JPRS-UAC-94-006
30 September 1994

FOREIGN
BROADCAST
INFORMATION
SERVICE

JPRS Report

Central Eurasia

AVIATION & COSMONAUTICS

Nos. 8,9-10, 11-12, 1993

Central Eurasia
AVIATION & COSMONAUTICS
Nos 8, 9-10, 11-12, 1993

JPRS-UAC-94-006 CONTENTS *30 September 1994*

[The following are translations of selected articles in the Russian-language monthly journal AVIATSIYA I KOSMONAVTIKA [Aviation & Cosmonautics] published in Moscow. Refer to the table of contents for a listing of any articles not translated.]

Development History, Features of MiG-27 Fighter/Bomber *[M. Pestrakov et al.*; No 8, pp 17-23] ... 1
Interbol Satellite System To Study Solar Wind, Magnetosphere *[R. Kremnev et al.*; No 8, pp 39-40] ... 8
Development History of Almaz Control Systems *[V. Polyachenko, A. Tumanov; No 8, pp 41-43]* ... 12
Articles Not Translated ... 16
Publication Data ... 16
Structure, Prospects of Military Space Forces
[Lieutenant-General S. Yermak, Major-General V. Menshikov; Nos 9-10, pp 2-3] ... 17
Russian Reusable Space Launch Systems Under Development *[S. Umanskiy; Nos 9-10, pp 12-14]* ... 20
Same Causes Seen To Persist for Air Crashes, Incidents
[Major-General of Aviation Ya. Yanakov; Nos 9-10, pp 22-23] ... 21
Articles Not Translated ... 25
Publication Data ... 25
Col-Gen Kot on Future of Air Forces *[Colonel-General V.S. Kot; Nos 11-12, pp 2-3]* ... 26
Psychological Causes of Improper Pilot Actions Analyzed *[Colonel V. Kozlov; Nos 11-12, pp 4-5]* ... 28
Development History of Tu-22 Bomber and Modifications
[S. Rigmant, A. Magashchuk; Nos 11-12, pp 11-15] ... 29
History and Prospects of the Jet Propulsion NII *[A. Koroteyev et al.*; Nos 11-12, pp 39-41] ... 34
Successes, Failures of Zenit Launch-Vehicle Program
[Major-General V. Menshikov; Nos 11-12, pp 42-43] ... 38
Articles Not Translated ... 40
Publication Data ... 40

Development History, Features of MiG-27 Fighter/Bomber

94UM0392A Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 8, Aug 93 (signed to press 7 Jul 93) pp 17-23

[Article by Lieutenant-Colonel M. Pestrakov, S. Anisimov and V. Ilin under the rubric "Domestic Aviation Hardware": "The MiG-27: A Fighter and a Bomber"]

[Text] *The article "The MiG-23: Strokes in a Portrait" (AVIATSIYA I KOSMONAVTIKA No. 7, 1991) presented the third-generation, multirole single-seat MiG-23 supersonic fighter. That aircraft, created in 1967 by the collective of the OKB [Experimental Design Bureau] under the supervision of A. Mikoyan, is a representative of one of the largest mass-produced series of jet fighters. The aviation specialists of many countries regarded the appearance of the MiG-23 as an important achievement in the Soviet school of design and aviation industry. The best aircraft in the world at the time for the defeat of mobile and fixed ground targets was created on the basis of the MiG-23.*

The creators of the MiG-23 aircraft, which was able to fight for air supremacy and defeat ground targets, at the OKB imeni A.I. Mikoyan realized the conceptual model for a multirole aircraft adopted in the NATO countries at the end of the 1970s. A wing with variable sweep in flight (with a range of variation of sweep angle from 16° to 72° at the leading edge) was employed for the first time in domestic aviation. The aerodynamic configuration provided the aircraft with good flight characteristics in cruising modes and in low-altitude flight, including at supersonic speeds close to the ground. It came to be understood, to the extent experience was accumulated in the utilization of the aircraft as a multirole aircraft, however, that the the designers had not been able to achieve full universality in its employment (the same way as the Americans had not in the creation of the F-111 multirole aircraft with a variable-geometry wing). Fighter/bomber versions of the MiG-23 were thus developed. This approach, using partial design changes, made it possible to reduce the expenditures for the creation of the new aircraft through the use of existing tooling at series-production plants, the standardization of a large number of parts and assemblies, and a reduction in the time for entry into operation.

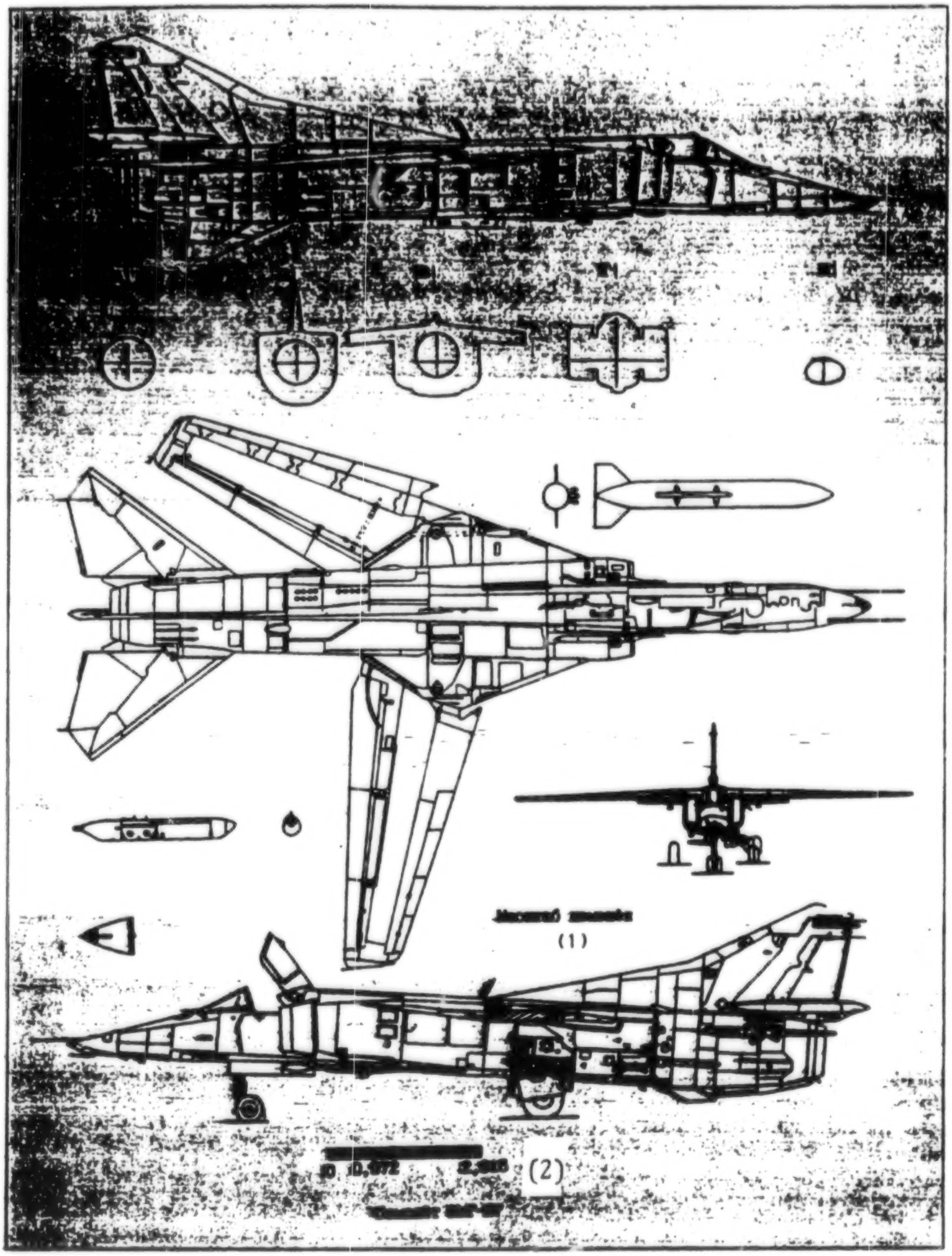
The variable-geometry wing, which had not acquitted itself in the best light in a maneuvering fighter, proved to be entirely acceptable in a fighter/bomber for low-altitude flights with basing at airfields with runways of limited length or even dirt airfields. The on-board systems and general-purpose weaponry of the MiG -23 were supplemented with new systems (for example, a thermal direction finder that made it possible to track a target under conditions of electronic jamming).

The principal feature of the aircraft, called upon to perform the mission of a fighter/bomber and receiving the designation MiG-23B, was the expanded range of armaments and, consequently, the altered on-board equipment, as well as its accommodation on the aircraft. The designers rejected an on-board radar set; the new shape of the nose portion of the fuselage provided an improved field of view from the pilot's cockpit. A glass aperture appeared in the nose fairing, intended for the optical portion of a laser rangefinder. The new KN-23 navigational system, in conjunction with an inertial heading and attitude indicator and an analog computer, made it possible to increase the precision of approach to a ground target. The engine designed by Khachaturov (usually installed in the MiG-23) was replaced with an AL-21F3 afterburning turbojet engine (1 x 8,000/11,200 kgf) developed at the design bureau of A. Lyulka.

The GSh-23L cannon under the fuselage of the aircraft, designed by Nudelman and Rikhter, was retained. SPPU-23 (23mm) cannon installations could also be mounted under the wing. R-3S missiles were mounted on the aircraft for defensive aerial battle. The MiG-23B began series production in this version in 1971. Twenty-four aircraft were built.

The MiG-23BN soon replaced the MiG-23B; it had the root portion of the moving part of the wing executed with a glove ("dogtooth"), the new R-29B-300 engine (1 x 8,000/11,500 kgf) and a modified KN-23 navigational system. Two additional external stores racks appeared on the tail section of the fuselage, as well as armored plates along the sides of the fuselage in the area of the cockpit. The construction of the MiG-23BN was done in a large series at the Znamya Truda MMZ. The OKB, while improving the design and equipment of the aircraft, developed the MiG-23BM version in 1973. The new 101523 digital computer, a PrKN-23 with markedly expanded capabilities and an optical sight increased its accuracy characteristics.

Some design changes to the nose portion of this aircraft were made (it soon received the designation MiG-27), the cockpit armor was made stronger, pressurization of the fuel tanks with an inert gas was employed and the GSh-23L cannon was replaced with the six-barrel GSh-6-30. It surpassed the American GAU-8A in many parameters, principally the increased rate of fire and smaller weight and dimensions (Table 1).



Key:
1. MiG-27 aircraft
2. scale altered

Table 1

Characteristics	GAU-8A	GSh-6-30
Number of barrels	7	6
Mass of body of weapon, kg	281	145
Maximum rate of fire, rounds/minute	4,200	600—5,600
Muzzle velocity of shell, meters/second	1,036	850
Mass of shell, grams	360	380
Standard ammunition load	1,174	250

The weight, increased by 4,000 kg compared to the MiG-23, and the requirement to provide for the possibility of operating the aircraft from dirt runways for direct support of the troops forced the designers to increase the width of the tires. This caused some changes in the lower portion of the landing gear—it became somewhat convex so as to fit the larger wheel into the interior of the aircraft fuselage.

The first MiG-27 was built in 1974 (with the test flight made by test pilot V. Menitskiy; A. Fedotov, B. Orlov, A. Fastovets, T. Aubakirov, V. Ryndin and other test pilots of the OKB and the LII [Flight Research Institute] also too part in the flight testing). The aircraft was series produced in different versions (MiG-27K, -27M) until 1984.

The appearance of the new fighter/bomber in the Air Forces went relatively unnoticed. The modest beginnings of the biography of the MiG-27, however, did not stop it from gradually becoming one of the most mass-produced aircraft in fighter/bomber aviation. It was produced abroad under license (in India) as well. The control system for moving the wing was altered in accordance with requirements for balancing the aircraft. Leading-edge and trailing-edge flaps were used across the entire wingspan at a sweep angle of 16°, and could deflect to 25° in takeoff and 50° in landing. The landing angle of attack was 15°. The aircraft used a cross-shaped braking chute with an area of 21 m^2.

The on-board equipment, along with the other systems, includes the SVS-P-72 air signals system, the SAU-23B1 system, which in conjunction with the on-board digital computer supports flights along a given heading, or navigational bombing in conjunction with the Fon laser rangefinder, a DISS-7 Doppler speed and drift angle indicator, RI-65 speech information systems, the SG-1 target detection radar, the SR30/SRO-1A target identification radar, the Tester-UZ flight data recorder and the RV-5R/RV radio altimeter (Table 2).

Table 2

Equipment	MiG-23BN	MiG-27	MiG-27K	MiG-27M	MiG-27D
PrNK	-	+	+	+	+
BTsVM	-	+	+	+	+
Sighting system	Sokol 23S	+	+	+	+
Navigational system	KN-23	KN-23	-	KN-23	KN-23
Laser rangefinder	+	+	-	-	-
Laser sighting system	-	-	+	+	+
RSBN	6S	6S	Korall	A-321	A-321
RSDN	-	-	-	+	+
SAU	23B	23B1	23BN	23B1	23B1
RV radio altimeter	5R	5R	A-031	A-031	A-031
Sighting head	+	+	-	+	+
Head-up display	-	-	+	-	-
Television indicator	-	-	+	+ for TGSN	+ for TGSN
Back-up heading vertical gyro	-	-	+	+	+
Armaments:					
cannon	GSh-23L	GSh-6-30	GSh-6-30	GSh-6-30	GSh-6-30
rockets:					
4 x (20 x 80mm)	+	+	+	+	+
4 x (32 x 57mm)	+	+	+	+	+

Table 2 (Continued)

Equipment	MiG-23BN	MiG-27	MiG-27K	MiG-27M	MiG-27D
aerial bombs (conventional/guided)	up to 3 tonnes/-	up to 4 tonnes/-	up to 4 tonnes/+	up to 4 tonnes/-	up to 4 tonnes/-
guided missiles (air-to-air)	R-3S	R-3S	R-60	R-60	R-60
guided missiles (air-to-surface):					
RKS*	-	+	+	+	+
TSN**	-	-	+	+	+
LSN***	-	-	+	+	+

*—RKS: with a radio-command homing system.

**—TSN: with a television homing system.

***—LSN: with a laser homing system.

The weapons control system of the MiG-27 provides for the automatic release of bombs either one by one or in a series, indications of bomb drop and their presence on board the aircraft (Table 3).

Table 3

Characteristics	Kh-25L	AS.30L	AGM-65A	AGM-65D
Year of issue	**1970**	**1987**	**1972**	**1985**
Type of homing system	laser	laser	television	television
Length of missile, meters	3.75	3.65	2.49	2.49
Wingspan, meters	0.85	1.00	0.72	0.72
Diameter of body, mm	275	342	305	305
Launch mass, kg	300	520	210	303
Mass of warhead, kg	110	250	57	136
Launch range, km	10	10	8	15

The MiG-27K, realized in 1977, was a later development of the MiG-27 (Table 4).

Table 4

Characteristics	MiG-23BN	MiG-27	MiG-27K	MiG-27M	MiG-27D	Su-17M4	Jaguar	A-7E	A-10A
Series production: start	1970	1974	1977	1978	1982	1979	1968	1965	1972
Series production: end	1970	1977	1982	1983	1985	1990	1980	1983	1981
Number of aircraft manufactured	export	560	200	150	500		40 (V-37 and "Ye")	1,545	500
Engine: type	R-29B-300 afterburning turbojet	R-29B-300	R-29B-300	R-29B-300	R-29B-300	AL-21 F3	Adour Mk. 804	TF-41-A	TF-34-G-100
Maximum static thrust, kgf	1 x 8000/ 11,500	1 x 8000/ 11,500	1 x 8000/ 11,500	1 x 8000/ 11,500	1 x 8000/ 11,500	1 x 8000/ 11,200	2 x 2380/ 3900	1 x 6800	2 x 4100
Mass of empty aircraft, kg	11,908	11,504	12,100	12,100	12,100	10,800	7,000	8,670	11,320
Takeoff mass, kg: normal	16,450	17,960	18,100	18,100	18,100	16,400	11,820	—	14,865
Takeoff mass, kg: maximum	21,000	20,560	20,670	20,670	20,670	18,500	15,700	19,050	22,680
Wing sweep angle, degrees	18; 45; 74	18; 45; 74	18; 45; 74	18; 45; 74	18; 45; 74	16; 72	fixed	fixed	fixed

Table 4 (Continued)

Characteristics	MiG-23BN	MiG-27	MiG-27K	MiG-27M	MiG-27D	Su-17M4	Jaguar	A-7E	A-10A
Wingspan, meters	7.781/ 13.97*	7.781/ 13.97*	7.781/ 13.97*	7.781/ 13.97*	7.781/ 13.97*	10.04/ 13.70*	8.69	11.80	17.53
Wing area, m^2	34.16/ 37.27*	34.16/ 37.27*	34.16/ 37.27*	34.16/ 37.27*	34.16/ 37.27*	34.50/ 38.50*	24.00	34.83	47.01
Length of aircraft, meters	17.076	17.076	17.076	17.076	17.076	19.010	16.83	14.10	16.26
Height of aircraft, meters	5.991	5.991	5.991	5.991	5.991	4.970	4.89	4.90	4.47
Mass of fuel in internal tanks, kg	4600	4560	4560	4560	4560	3630	3280	3500	4853
Unit load on wing, kg/m^2	590	605	605	605	605	—	—	—	—
Top speed, km/hr:									
at H = 10,000 meters	1,800	1,800	1,800	1,800	1,800	1,850	1,700	1,112	705
at ground level	1,350	1,350	1,350	1,350	1,350	1,400	1,290	1,112	705
Landing speed, km/hr	260	260	260	260	260	—	213	—	—
Combat radius with one tonne load, km	850	800	800	800	800	—	—	—	—
Flight range without external tanks, km	1,750	1,750	1,750	1,750	1,750	560**	1,700	—	—
Flight range with external tanks (ferry), km	—	—	—	—	—	2,300	4,200	—	3,950
Takeoff run, meters	950	950	950	950	950	800	880	—	1,120
Landing runout without parachute, meters	1,300	1,300	1,300	1,300	1,300	—	680	—	—
Landing runout with parachute, meters	900	900	900	900	900	950	—	—	—
Maximum operating G-forces	7.5	7.5	7.5	7.5	7.5	7.0	7.5	6.0	7.0
Number of barrels (cannon armament)/caliber	2/23	6/30	6/30	6/30	6/30	2/30	6/20	7/30	—
Number of shells	250	250	250	250	250	320	—	1,000	117
Maximum mass of bomb load, kg	3,000	4,000	4,000	4,000	4,000	4,500	6,800	7,250	—

*—at sweep angle (χ = 18°, 74° for all versions of aircraft "32"), (χ = 16°, 72° for Su-17M4).

**—in flight with PMB.

The aircraft is fitted with more advanced on-board equipment. This includes, in particular, the SAU-23BN (part of the PrNK-23K) and the Kayra infrared-television guidance channel. The Kayra optical set can move the line of sight within a limited sector (from +6° to -160° for the vertical channel, and from +35° to -35° for the horizontal channel), supporting the tracking of a target during aircraft maneuvering. The illumination is accomplished in programmed mode—that is, the laser beam automatically deflects to a certain angle depending on the speed of movement of the aircraft, and is held on the target continuously. The size of the optical window for the laser rangefinder has been increased. The use of standard on-board equipment for the laser guidance systems provides an opportunity to guide the weapons.

This aircraft was built for a long period of time. Dozens of MiG-27 aircraft were also retrofitted in 1982-84. These were the MiG-27D version, fitted with the PrNK-23M and the Klen laser rangefinder (replacing the Fon). Small fairings appeared on the fixed portion of the wing with SPO antennas, improving slightly the aerodynamic characteristics of the aircraft at large angles of attack. The aerodynamics of the cannon mount under the fuselage were altered as well (the fairing of the breech section was enlarged, and exhaust gas deflector panels were installed). The aircraft armaments also included two SPPU-23s with barrels that turn on the vertical plane at fixed angles of 0, 6.5 and 11°, increasing the time that a target could be fired on from horizontal flight.

New electro-optic sighting equipment and a laser rangefinder were installed in the nose portion of a modification of the MiG-27M aircraft, and the range of armaments was expanded (the aircraft began to be equipped in particular with pods for "scattering" small-caliber bombs).

The color scheme of the series-produced MiG-27 aircraft was three-color—and later four-color—camouflage painting. Some aircraft, prepared for use at night, were painted a dark gray, almost black, color.

The export version of the MiG-27 was the MiG-27L, produced under the name of Bahadur ("Valiant") in India by the firm of HAL at the aircraft plant in the city of Nasik. The assembly of the first Indian MiG-27 from parts delivered from the USSR (for 50 aircraft) was completed on 11 January 1986, and the building of purely Indian Bahadurs began in 1988. The production of 165 aircraft of this type in all is expected in India, and it should constitute the foundation of the striking power of the Indian Air Force in the 1990s by replacing the Su-7B and Canberras in line units.

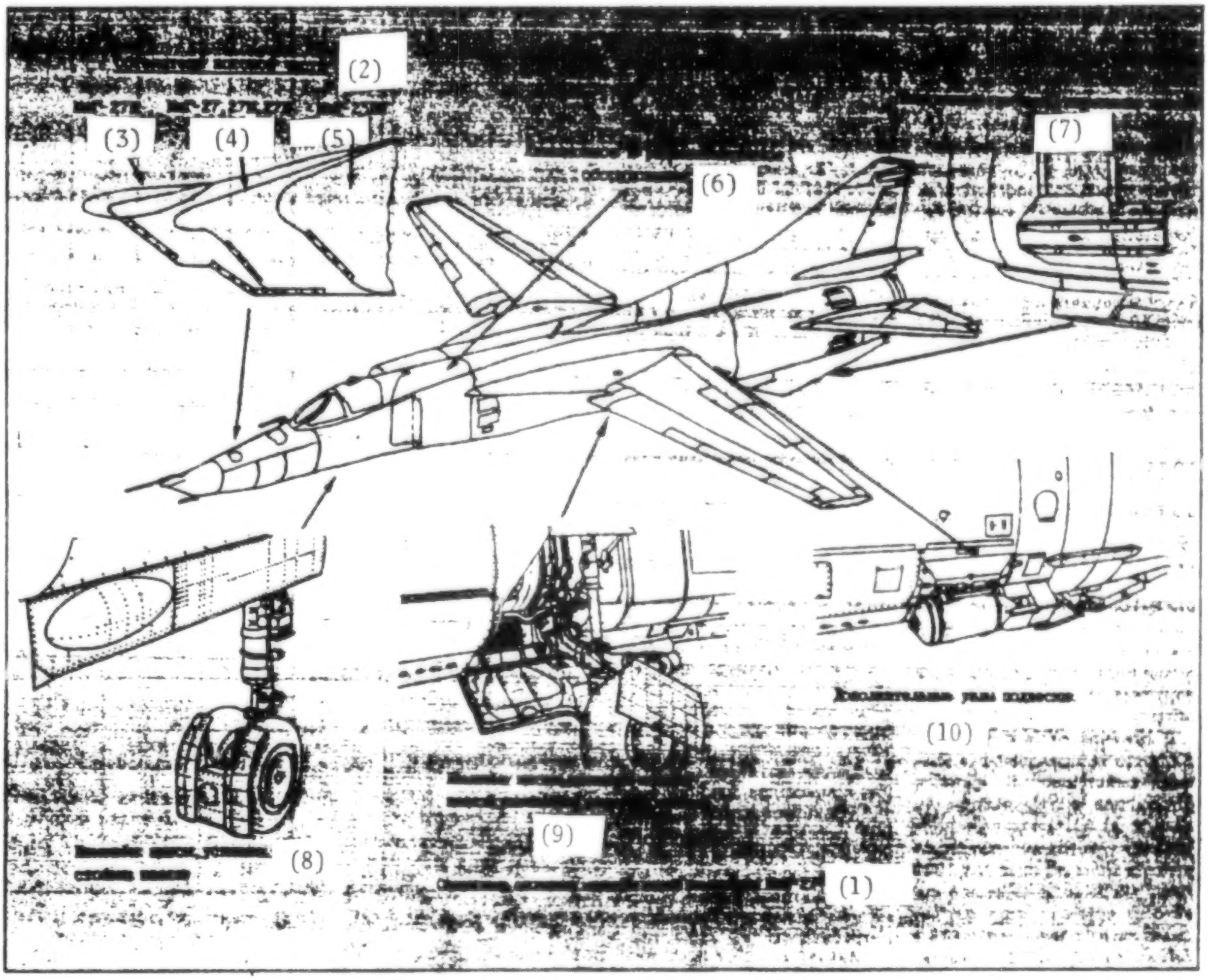
The MiG-27, as opposed to the MiG-23, has almost never been employed in combat operations. A regiment of MiG-27s was sent to Afghanistan in October of 1988 (city of Shindand), and was used in battles until February 1989, when the withdrawal of Soviet troops from the country began. The MiG-27, taking into account the experience of combat operations in Afghanistan, was fitted with VP-50/60 containers instead of the KDS-23, with decoy flares (false targets) placed on the fuselage in containers reminiscent in shape of aerodynamic fences.

As recently as two years ago there were more than 830 MiG-27 aircraft of various versions in service with our Air Forces; they were second in numbers, that is, only to the Su-17, of which there were more than 1,000 in service with fighter aviation at the end of 1991.

Comparing the MiG-27 with other aircraft for similar purposes, one should note the better armoring (the MiG-27 is inferior only to the A-10A (United States) and the Su-25 attack aircraft in armor protection; the Su-17, Jaguar, Voight A-7 and Q-5 (PRC) all have only front, rear and lower armoring for the cockpit, with the sides remaining unprotected). The MiG-27 is also superior in cannon armament to all aircraft except the A-10A, but it lags other analogous aircraft except the Q-5 (based on the MiG-19) in the mass of the bomb load. The MiG-27 is roughly equal to the Jaguar aircraft in the number of units of high-precision weaponry (two to four X-25 and two AS.30L guided missiles), but is inferior to the A-7E and the A-10A (six AGM-65 Maverick guided missiles). The top speed of the MiG-27 exceeds virtually all foreign aircraft of the same or similar classes (the American attack aircraft do not reach supersonic speeds at all), but is inferior to them in flight range (the lesser economy of domestic engines has an effect).

The on-board electronics equipment of the MiG-27 is optimal. Only the Jaguar and the latest version of the Q-5 of the aircraft listed above, for example, have a laser set, created with the aid of Italian firms; the A-10A and A-7 are fitted only with receivers for laser illumination, making it possible to detect targets that are illuminated by ground target designators.

It should be acknowledged that the MiG-27 is a successfully executed aircraft overall, whose design harmoniously combines requirements that are generally difficult to make compatible with aircraft of this class. The simplicity and expediency of the engineering ideas employed in the aircraft, and the maximum possible standardization with the principal front-line fighter of the 1970s and 1980s—the MiG-23—are also noteworthy.



Key:
1. Principal differences among modifications of MiG-27 aircraft
2. Nose fairing
3. MiG-27K
4. MiG-27, 27M, 27D
5. MiG-23BN
6. avionics and electronic equipment
7. rotating fin, brake panels
8. panel altered, landing-gear strut strengthened
9. panel altered, landing-gear strut strengthened, wheel dimensions increased
10. additional stores racks

Interbol Satellite System To Study Solar Wind, Magnetosphere

94UM0392B Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 8, Aug 93 (signed to press 7 Jul 93) pp 39-40

[Article by R. Kremnev, A. Smirnov and I. Saymagambetov under the rubric "Space Science for Science": "The 'Interbol' Project"]

[Text]

The Target

The Earth, as is well known, does not exist in isolation in space. The sun in particular has a very large effect on it. It largely determines the nature of the weather and the climate as a whole, the general state of people and the vital activity of everything animate and inanimate on our planet.

The influence of the sun, however, has been little studied nonetheless. That is why Russia is working in concert with the scientists of other countries on the Interbol project. The principal aim is to continue basic scientific research in the realm of Earth-sun physics, but at a qualitatively new level. The processes of generation of various types of energy on the sun, its transfer to the Earth and the effects on the properties of near-Earth space will all be studied.

The so-called solar wind—intensive plasma fluxes emitted continuously from the sun's corona, which accelerate with distance from the sun—was detected back at the beginning of the space age. The solar wind, racing into the Earth's magnetic field, forms a comet-shaped region—the magnetosphere. Its boundary extends approximately 70,000 km from the center of the Earth on the side facing the sun. The magnetosphere extends for many millions of kilometers in the opposite direction, forming a magnetic tail for the Earth. Much research performed with the aid of spacecraft has made it possible to study, to a considerable extent, the configuration of the magnetosphere and the characteristics of the plasma that fills it. General impressions have also been obtained of the energy of the magnetosphere and some of the processes that are responsible for its activity. It is manifested, for example, in the form of powerful magnetic storms and various types of electromagnetic emissions in various regions of the spectrum (the polar lights and magnetospheric bursts of radio emissions, among other things).

The accumulation of an enormous amount of energy—about 10^{23} ergs in the form of the energy of the magnetic field—occurs as a result of the interaction of the Earth's magnetosphere and the solar wind. When it reaches a certain level, it is transformed into the energy of rapid plasma fluxes and high-energy particles. The electrical fields and currents generated therein are grounded with the current-conducting ionosphere of the Earth, causing magnetospheric substorms. Their relationship, for example, with disruptions of radio communications and the disabling of electrical-transmission lines and telegraph communications has been scientifically substantiated. The problem of the study of the mechanisms of substorms is a most important, and as yet unresolved problem, in the physics of the magnetosphere, and their study has thus become the chief task of the project. The receipt of information is also expected on the radiation environment in near-Earth space, along with the performance of dosimetric research for the further development of means and methods of protection against radiation.

It has become clear of late that progress in the study of the links between various geophysical phenomena in the magnetosphere can be achieved only with the use of measurements obtained simultaneously from several satellites that are far apart. Only that approach will permit the determination of the cause-and-effect links of the phenomena under consideration. The organization of the simultaneous operation of two pairs of satellites is thus planned for the realization of the Interbol project (Fig. 1). One of them—with a main satellite and a subsatellite—will be operating in a highly elliptical orbit with its apogee passing through the tail region of the magnetosphere at a distance of more than 100,000 km from Earth. The other pair, with the same composition, will occupy an orbit with an apogee altitude of 20,000 km, intersecting the region of the Earth's magnetosphere facing the sun (auroral) over the oval of the polar lights.

The main satellite and subsatellite will be recording the parameters of one and the same physical processes, but the subsatellites will have less detail. The distance between them will be established with the aid of a corrective engine installation on the subsatellite, depending on the type of measurements.

The new automatic Prognoz-M2 spacecraft from the Scientific Test Center imeni G.N. Babakin will be used as the main satellites. The subsatellites are being created by the Geophysical Institute of the Academy of Sciences of the Czech Republic.

The scientific apparatus (NA) is being developed through international cooperation with the participation of Russia, Bulgaria, Cuba, Poland, the Czech Republic, Slovakia, Austria, Canada, France, Sweden, Germany, Greece, Finland and the European Space Agency (Holland, Italy). The lead organization for the scientific apparatus is the Institute of Space Research of the Academy of Sciences of Russia.

Ballistic Characteristics

The placement of the Prognoz-M2 spacecraft into working orbit is accomplished as follows. The main unit, consisting of the booster unit and the spacecraft, is placed in intermediate Earth orbit using the three-stage Molniya launch vehicle. The engine installation of the booster unit is started during the first circuit in the intermediate orbit in order to reach the necessary velocity, as a result of which the spacecraft is moved to the satellite working orbit.

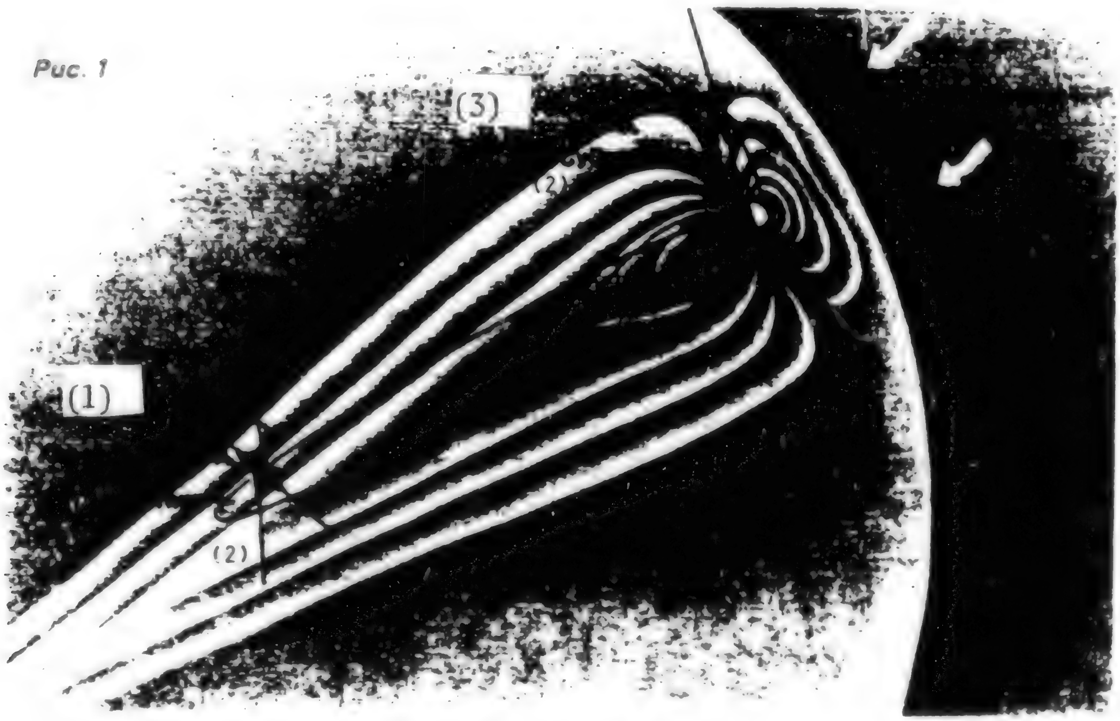


Fig. 1.

Key:
1. tail probe
2. subsatellite
3. auroral probe

Parameters	Intermediate orbit		Working orbit	
	tail spacecraft	auroral spacecraft	tail spacecraft	auroral spacecraft
Altitude of perigee, km	235	235	315	770
Altitude of apogee, km	505	835	200,000	20,000
Inclination to equator, degrees	65	65	65	65
Rotational period, hours	1.5	1.6	96	6
Duration of shadow, hours	—	—	5	1

The principal initial characteristics of the intermediate and working orbits are shown in the table.

The tail spacecraft—the one that serves for the study of the tail portion of the magnetosphere—is the first to be put into the satellite working orbit. The launch of the auroral spacecraft is planned a month later.

The Prognoz-M2

The principal structural assembly of this spacecraft is the cylindrical, airtight instrument container (Fig. 2). The service gear and electronic units for a number of the scientific instruments are mounted on two frames (2) inside it. Four solar arrays (3), solar sensors (4), a spherical tank with the orientation system working medium (5) and brackets with gas engines and antennas for Earth communications (6) are attached to the outside, as are an upper plate (7), side frames (8) and an adapter (9) for the mounting of scientific instruments (10) on the outside of the spacecraft. Rods are mounted on the solar arrays on which sensors are located for measuring the magnetic and electrical fields and antenna of the telemetric support system. The subsatellite is mounted in the lower portion of the spacecraft on a truss located in the central portion of the adapter plate.

The solar arrays, rods and one of the antennas for Earth communications are under the fairing of the launch vehicle in stowed position during the launch into orbit. They are deployed in the working orbit.

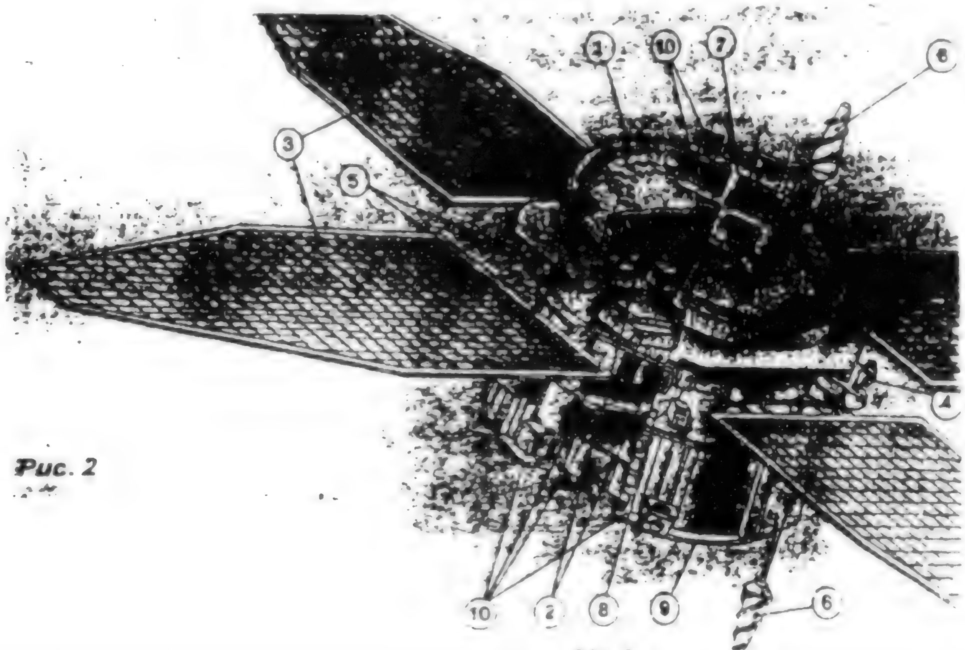


Рис. 2

Fig. 2.

Principal Characteristics of the Prognoz-M2 Spacecraft	
Initial mass of spacecraft, kg	1,250—1,350*
Mass of scientific gear, kg	250—350*
Power consumption of scientific gear, W	250
Term of active existence of spacecraft	not less than one year
Orientation mode of spacecraft	continuous solar (the spin of the spacecraft around an axis oriented toward the sun is ensured)
Angular velocity of spin, deg/sec	1
Precision of training spin axis of spacecraft on the sun during orientation sessions, degrees	1
Allowable angle of deviation of axis of spacecraft spin away from the sun, degrees	10
Precision of knowledge of instantaneous angular position of spacecraft in inertial space, degrees	0.5
Working medium of orientation system	nitrogen
Number of functional radio commands for control of scientific gear	256

Principal Characteristics of the Prognoz-M2 Spacecraft (Continued)	
Number of addresses for transmission of numerical radio commands to scientific gear	32
Number of telemetric inputs	16 digital, 512 analog and discrete
Capacity of on-board recording device, MB	30 as part of radio complex, 100 as part of scientific gear
Information content of "spacecraft—Earth" radio links, kilobaud	up to 16 in reproduction mode, up to 65 in direct transmission mode
Dimensions of spacecraft, meters:	
in stowed position	2.3 (diameter), 5.0 (height)
in deployed position	22 x 22 x 12.5

*—The first and second numbers pertain to the spacecraft for studying the tail and auroral regions of the magnetosphere respectively.

Solar arrays in which the photoconverters are covered with a current-conducting coating on the inside and outside and electrically connected to the body of the spacecraft, as well as metal-coated vacuum-screen thermal insulation electrically connected with the body of the spacecraft, are employed on the Prognoz-M2 spacecraft for a substantial reduction in electromagnetic and electrostatic interference.

The Subsatellite

The subsatellites are intended for measurements of the parameters of the space environment simultaneously with the main satellites, with the aim of delimiting their spatial and temporal variations. Their scientific apparatus makes it possible to measure the characteristics of magnetic and electrical fields, as well as cold and superhot plasma.

Principal Characteristics of the Subsatellites	
Mass, kg	49
Mass of scientific instruments, kg	7
Power of solar arrays, W	27
Orientation mode	continuous solar
Stabilization mode	gyroscopic
Angular velocity of spin	1—3
Allowable angle of deviation of spin axis away from sun, degrees	15
Precision of knowledge of orientation in space on each axis, degrees	less than or equal to plus or minus 2
Information content of radio links:	
subsatellite—Earth, kilobaud	2.56—20.48
Earth—subsatellite, baud	128
Capacity of on-board recording device, MB	4
Characteristic speed of corrections, m/sec	up to 6

They are mounted on the main spacecraft, with separation performed after the entry of the spacecraft into their working orbits.

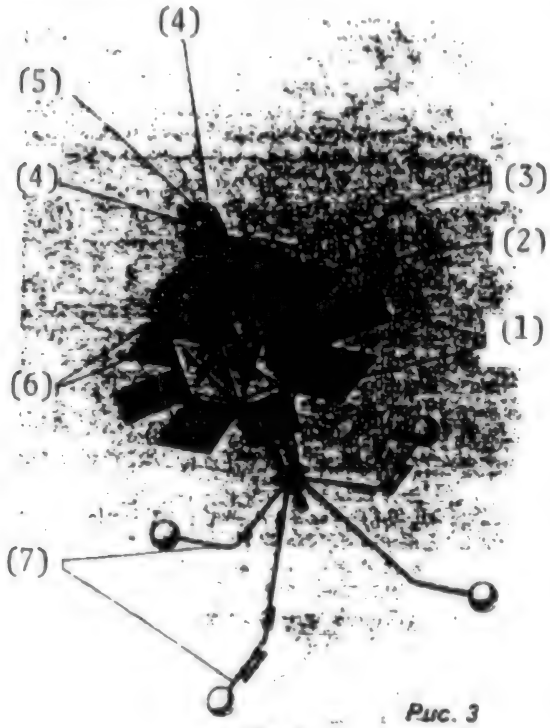


Fig. 3.

The central body of the subsatellite (Fig. 3) is a non-sealed 24-faceted body with retractable (1) and fixed (2) solar arrays and antennas (3) attached to it. The correcting engine installation is installed on the lower base, along with the solar sensor (5). The scientific instruments (6) are installed on the body and on retractable booms (7).

The electronics of the service gear and scientific instruments are in the form of circuit boards inside the central body.

Research under the Interbol project is projected to begin at the end of this year or the beginning of next year. It will undoubtedly have unique results.

Development History of Almaz Control Systems

94UM0392C Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 8, Aug 93 (signed to press 7 Jul 93) pp 41-43

[Article by V. Polyachenko and A. Tumanov under the rubric "From the History of Space Science": "The Controllable 'Almaz'"]

[Text] *The Almaz space system was developed in the middle of the 1960s at the design bureau (TsKBM) headed by Vladimir Nikolayevich Chelomey. It consisted of a manned orbital station (OPS), a return craft (VA) for the descent of the cosmonauts from orbit, and a large-capacity supply transport ship (TKS). It must be said that the TsKBM was engaged in diverse pursuits. Sea-, ground- and air-launched cruise missiles, ballistic missiles and launch vehicles followed, of which the mightiest—the Proton—is still putting heavy spacecraft and stations into orbit. All of these craft had to have modern and effective control systems (SU). The general designer considered it necessary to develop their own SU, and a theoretical-instruments complex was thus organized at the KB [design bureau] in 1957. This article will discuss first and foremost the control system for the Almaz, unique for its time. It was that system that determined, to a considerable extent, the capabilities of the entire complex.*

The manned orbital stations of the Almaz system, which operated in space under the names of Salyut-2, Salyut-3, Salyut-5 and the Salyut-1 or Salyut-4 long-term orbital stations (DOS) from the KB of V. Mishin (TsKBEM), had a great deal in common, since they used the structural elements of the orbital station created at the TsKBM for the Almaz system as their foundation. They were of identical mass, manufactured at the same plant and launched by the Proton launch vehicles. The crews were also delivered to those stations in Soyuz vessels of the same type.

They differed, at the same time, in their "internal content." The Almaz OPS performed the functions of a "space eye," tracking the Earth. This presumed a lower orbit and a constant long-term orientation toward the Earth, while the search for and observation of "interesting" ground targets posed increased demands on the SU for orientation precision. This was not required of the DOS.

The TsKBM acted as the lead developer for the OPS control system. The collective could handle this work, as it had specialized subdivisions in its composition. A preliminary design for an OPS and VA control system was successfully defended in 1967, and in 1968 all of the documentation was transferred to the Kiev Radio Plant (KRZ) for the manufacture of the instruments. A large group of staffers from TsKBM worked there for more than three years without a break, adopting, tuning and adjusting the devices being developed. The plant collective, headed by director Dmitriy Gavrilovich Topchiy, provided invaluable assistance.

The first ten sets of apparatus manufactured by the KRZ were tested out completely on the ground, including testing under the operative factors of actual flight, and in January of 1973 they began preparations on the test range.

The on-board control systems of the OPS had 69 units and more than 200 cable lines linking them with each other and with the instruments of other systems of station equipment. It was to perform the tasks of controlling the movements of the OPS from the time of its separation from the launch vehicle to the end of its existence, *i.e.* to the issue of the braking pulse for entry into the dense layers of the atmosphere.

New engineering ideas were employed in the development of the SU, since the Salyut-3, Salyut-5, Kosmos-1870 and Almaz-1 stations were equipped with a large

set of systems for visual, photographic, radar and infrared observations of the Earth. A decentralized control system (consisting of several subsystems), which possessed a series of substantial advantages compared to a centralized one, was employed for the first time. The time periods for its creation were reduced, first of all by simultaneous working on each subsystem, and the reliability was improved thanks to the more extensive monitoring of its parameters.

The SU consisted of subsystems for orientation, stabilization, control of the movement of the center of mass of the spacecraft, navigation, and program-control apparatus, each of which performed its own tasks according to its own algorithms.

The flight control system of the station was structured using analog elements, since on-board digital computers (BTsVM) that functioned continuously for a year did not exist at the time. It is worth noting, however, that at that very time, in 1967, they designed an SU for the return vehicle at the TsKBM using the Argon-12 control BTsVM developed by the All-Union Scientific-Research Institute of Digital Computer Technology. This was justified, since the functioning time of the VA (15 days) was considerably less than that of the OPS. Two more powerful Argon-16A BTsVM were also accommodated on board the OPS itself to control the observation apparatus. No specialized organization at the time would take on the creation of reliable digital machines with a service life equal to the time of active existence of the OPS.

The SU performed the constant orientation of the station toward the Earth for the first time over the whole flight time of the Almaz. This became possible thanks to the new electro-mechanical stabilization system (EMSS) with a spherical flywheel, which required almost no fuel. The performance of rapid rotations on the roll angle at a velocity of one degree per second within range of plus or minus 75 degrees, to expand the field of view of the observation gear, was a large problem for a spacecraft of this type. The task was accomplished using a ring flywheel of the EMSS system with a large kinetic moment (more than 100 nanometer-seconds) "incorporated" into the dimensions of the forward compartment of the station, 2.9 meters in diameter.

The collective of the VNII [All-Union Scientific-Research Institute] for Electromechanics headed by Academician Nikolay Nikolayevich Sheremetyev developed the EMSS according to the technical specifications of the TsKBM. The spherical engine-flywheel with electromagnetic rotor suspension was unique. It had a marked advantage compared to the three flat engine-flywheels that were employed to stabilize the spacecraft—there were no harmful gyroscopic moments in the rapid rotations of the OPS. The spherical flywheel moreover proved to be half as heavy as the three flat flywheels at identical moments of inertia.

The required precision of orientation of the Almaz station was achieved through the realization of a number of original engineering ideas. A method of correcting the gyroscopic system of orientation with a Doppler signal formed by an instrument of the radar observation gear was used in the mode of radar observations of Earth targets. The cumulative error of orientation and stabilization along the heading channel was not more than one angular minute. The system employed a gyroscopic orientation instrument developed by a collective at the NII [Scientific-Research Institute] of Applied Mechanics under the supervision of Chief Designer Academician Viktor Ivanovich Kuznetsov.

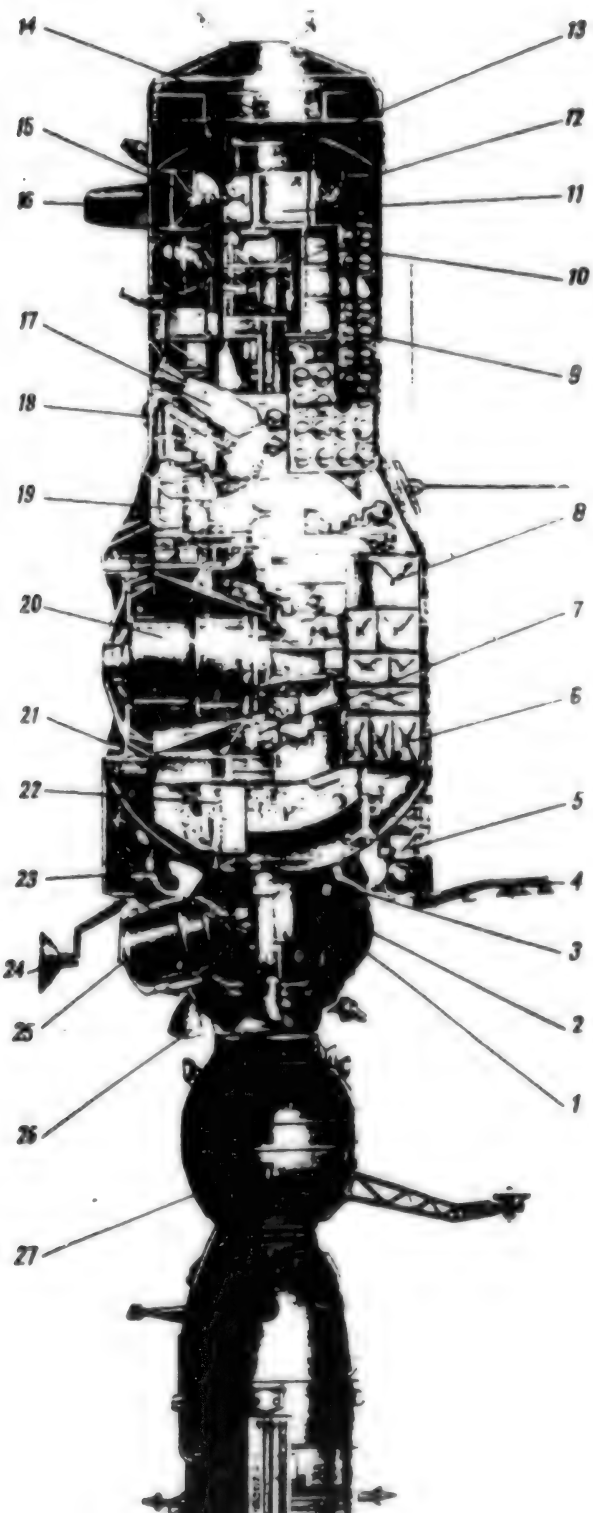
The control system had little power consumption thanks to the widespread application of "cold" back-up subsystems, instruments and units (where the back-up device is turned on only in the event of a failure of the main one). It was 200—400 watts depending on the modes, and an additional 180 watts during the operation of the EMSS, which used electric power principally from the solar arrays. The fuel consumption of the micro-ZRDs [liquid-fueled engines] was just 10—15 grams per orbit, with was 20—40 times less than the use of only the jet systems of the liquid-fueled engine.

The high reliability of the SU was ensured thanks to "cold" and "hot" back-up, and automatic changes in the structure of the SU according to signals from the monitoring devices. Transition was made, in the event flaws were detected, from a more complex control system to a simpler but more reliable one. The precision mode, for example, was replaced with an economical one, and the economical with a damping mode or a spin mode, also using different types of control elements.

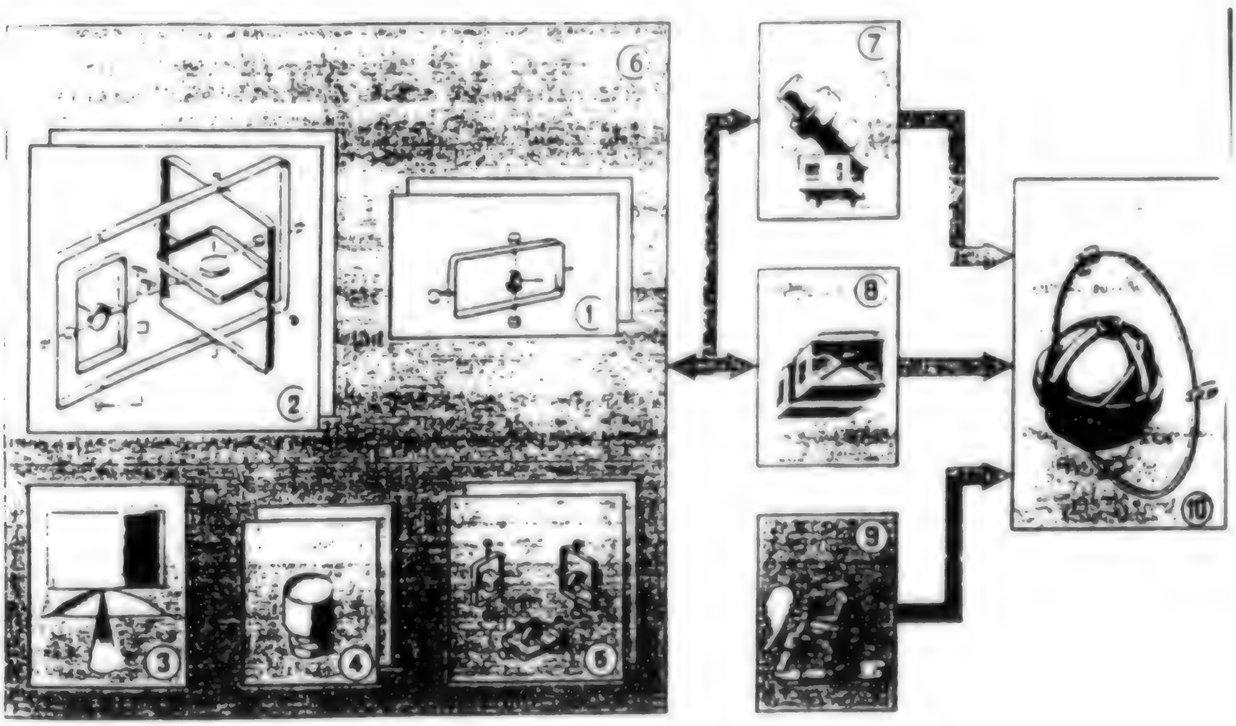
Also topical was the efficient structuring of the on-board automatic monitoring, which made it possible to connect the "cold" back-ups to units or instruments and eliminate possible non-standard situations, for instance in the burnout of the engine, the complete burn-up of the fuel, uncontrolled rotations of the spacecraft etc.

Monitoring was also used, aside from assessing the status of individual instruments and units, employing summary criteria or cumulative negative results. This made it possible to encompass the check-out of a large number of SU elements and ascertain their failure using few resources. The system then switched to other instruments.

The multitiered principle of efficiency of control was used in the development of the SU. What does that mean? In the mode of orbital flight or precision orientation, where high efficiency of the control elements is not required, the spherical flywheel with a small control moment is used. When countering disturbances that arise, for instance during the process of orbital correction, a special switching device is actuated automatically according to the angle of deviation of the spacecraft, and the liquid-fueled engine with a large control moment begins to operate. The ring engine-flywheel, which also has a large controlling moment (200 nm), is turned on in the event of rapid rotations on the roll channel.


14
13
15
12
16
11
10
17
9
18
19
8
20
7
21
6
22
5
23
4
3
24
25
2
26
1
27

Key:
1. air lock
2. exit hatch to space
3. hatch for passage to air lock
4. docking system antenna
5. scientific apparatus
6. stabilization system instruments
7. gyroscopic orientation instrument
8. program-control instruments
9. life-support system
10. living compartment
11. ring flywheel instruments
12. ring flywheel
13. spherical flywheel instruments
14. stabilization micro-engines
15. spherical flywheel
16. infrared vertical
17. panoramic scan device
18. radio vertical gyro
19. optical viewer
20. telescopic lens
21. telephoto system
22. physical trainer
23. engine installation
24. information transmission antenna
25. information drop capsule
26. orbital correction engine
27. Soyuz transport ship



Block diagram of control system

Key:
1. gyroorbiter (heading gyro)
2. orientation gyro instrument
3. radio vertical gyro
4. infrared vertical
5. angular velocity sensor
6. orientation system
7. center-of-mass movement control system
8. program-control system
9. manual control system
10. electromechanical stabilization system

The control system can operate in the modes of precise orientation and stabilization of the OPS relative to an assigned position, the restoration of the orientation of the station from any disoriented position, and the spinning of the OPS to organize the long-term "storage" of the station in orbit.

A system of semi-automatic (manual) control (SPU) was developed and used for the manned Almaz stations (Salyut-3 and Salyut-5), using which the cosmonaut pilot could perform the orientation and stabilization of the station with the required precision. He could also, by observing ground targets in the optical viewer, "take" a target that interested him into the crosshairs of the viewer with a slight turn of the control stick. The signal from the stick at that time entered the computer device of the SPU, where the control commands were formulated by which the station "covered" the selected target with the whole arsenal of observation equipment. This was a very convenient device for the cosmonauts, as was confirmed by P. Popovich, Yu. Artyukhin, B. Volynov, V. Zholobov, V. Gorbatko and Yu. Glazkov.

The control system of the OPS also possessed these capabilities. They were realized in flight testing. The manned Salyut-3 and Salyut-5 flew 273 and 412 days respectively, while the automatic Kosmos-1870 and Almaz-1 went 731 and 566 days. There was not one failure of the control systems during all of those flights, and they operated continuously using the main apparatus.

The collective of the Machine-Building NPO [Scientific Production Association], under the supervision of General Designer G. Yefremov, is working today on the creation of improved space stations for remote sounding of the Earth in the interests of all of mankind. The accumulated experience in the development of the control systems is assisting in the realization of those projects.

Articles Not Translated

00000000 Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 8, Aug 93 (signed to press 7 Jul 93)

[Text]

Winged Holiday (S. Sinikchiyants) C2

The Way It Was (From the Recollections of an Eyewitness) (A. Khalutin) 2-3

The 'Voskhod-93' Exercise: A Leap Across Six Time Zones (S. Valchenko) 4-11

The Personality Factor in the Accident Rate (I. Pstygo) 12-13

'Computer Reasoning': The Incursion Continues (S. Pochuyev) 14-15

On Guard of the Weather (B. Belokopytov) 15-16

Return to War (M. Syrtlanov) 16-17

Military-Transport Aircraft (Il-76 and Lockheed C-141) (N. Vasilyev) 26-27

First Military Pilot (A. Kravets) 28-29

Golden Autumn of the Academician (B. Afanasyev) 29-30

The 'Russian Knight' (V. Zaretskyy) 30-31

Air Aces (P. Bogdanov, A. Shcherbakov) 32-33

The 'Tenderfoots' Go Into Battle (A. Krasnov) 34-35

My Flight Log (A. Markusha) 36-38

The American 'Apollo' (S. Shamsutdinov, I. Marinin) 44-46

UFOs: Hypotheses, Facts, Opinions (S. Sergeyev *et al.*) 47-48

The Air Forces of the Moscow Military District—75 Years! (S. Pashkovskiy, S. Skrynnikov) C3

Publication Data

94UM0392E Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 8, Aug 93 (signed to press 7 Jul 93)

[Text] English title: AVIATION AND COSMONAUTICS

Russian title: AVIATSIYA I KOSMONAVTIKA

Editor: V.V. Anuchin

Publishing house: Voyenizdat

Date of publication: August 1993

Signed to press: 7 Jul 93

Structure, Prospects of Military Space Forces

94UM0393A Moscow AVIATSIYA I KOSMONAVTIKA in Russian Nos 9-10, 1993 (signed to press 9 Nov 93) pp 2-3

[Article by Lieutenant-General S. Yermak and Major-General V. Menshikov: "The Military Space Forces of Russia"]

[Text] *The Military Space Forces were organizationally split off under the reforms of the armed forces by order of the Minister of Defense of the Russian Federation at the beginning of 1993. A host of questions had to be answered in substantiating that decision, first and foremost just what Military Space Forces are needed by Russia and whether they are needed at all, as well as whether they will prove to be an excessive burden on the economy of Russia in its grave state.*

The USSR and the United States began to employ space hardware in the interests of the armed forces starting in the 1960s, virtually immediately after the launches of the first satellites.

How were the VKS [Military Space Forces] of Russia created, and what are they today?

The first military formations for space purposes were formed in the second half of the 1950s as part of the Strategic Rocket Forces [RVSN] in preparation for the launch of the first artificial Earth satellite. The organized structure of the space units by the end of the 1950s included a testing directorate, separate engineering and test units and a telemetry test complex at the Baykonur test range, scientific-research directorates and separate scientific-telemetry stations at the center of the command, control and telemetry system. The Central Directorate for Space Hardware of the Ministry of Defense was created in 1964 to centralize the work to create new space hardware, as well as for the prompt resolution of questions of the employment of space systems. Major-General A. Karas was named chief. It was re-organized into the Main Directorate for Space Hardware (GUKOS) of the Ministry of Defense in 1970, to develop space hardware in the interests of all branches of the armed forces of the USSR, the national economy and scientific research. It was headed by Major-General A. Maksimov starting in 1979.

The GUKOS and the units subordinate to it were removed from the RVSN and subordinated directly to the Minister of Defense of the USSR in 1982, since the amount of tasks being performed had grown. The creation of the Military-Space Forces of the Russian Federation, whose first commander is Colonel-General V. Ivanov, was a natural and logical step in this process.

It must be noted that improvements in the organization of the management of space systems development and employment in the United States took the path of reforming the corresponding structures of the Department of Defense as well. First there were separate space units, then the space commands of the Air Force, Navy and Army. Today there is a Joint Space Command.

The VKS are currently equipped with imaging and electronic surveillance gear, ballistic-missile launch warning systems, space systems and systems for communications and relay, navigation, topography, geodesy, meteorology, and means for launching and controlling orbital forces. This hardware possesses the unique properties of a global nature and high operativeness, which makes it possible to resolve the tasks of supporting the troops either more efficiently or with lesser expenditures than non-space means for analogous purposes.

The satellites make it possible to conduct surveillance of targets and regions at land and sea, with subsequent discrete transmission of the information to receiving and processing stations. The data received are widely employed for military, national-economic and scientific purposes.

The space ballistic-missile early-warning systems are able to detect the fact of missile flight and transmit a signal to Earth within one or two minutes after their launch. There is obviously no need to talk about the acute scarcity of time to gather such information, since the decision must be made for a reciprocal strike. Operative first-line means of detecting missile launches are thus the main ones in the strategic warning system. It is also fundamentally important that they provide an opportunity for global surveillance, since the places where missile units are stationed on land are dispersed, while nuclear-powered missile submarines can be on patrol at any point in the world's oceans.

Communications, data relay and television broadcasting by satellite have also become widespread here and abroad. Our orbital group of communications satellites supports the steady operation of several thousand channels in various modes with subscribers at all points on the globe and the transmission of data through relay satellites in virtual real time among land, sea, air and space receivers and transmitters, as well as television broadcasting, which is especially important for regions of Russia remote from Moscow. An orbital group of such satellites is constantly deployed, functioning and has the necessary back-ups. It currently consists of several dozen spacecraft.

Space navigation was used first of all in the interests of the Navy. The first navigational and communications satellites had serious drawbacks, however—large errors in the determination of target coordinates, and the impossibility of providing information around the clock. Ships at sea, moving ground equipment, aircraft and spacecraft can currently determine their position at any point on the globe with an error of tens of meters at any point in time.

The creation and employment of space systems for topography and geodesy were initially linked with the need to increase the accuracy of ICBM warheads striking

their targets. High-precision geodesic referencing of the continents, launchers and targets, specification of the parameters of the Earth and creation of terrain maps of remote military geographic locations were required for that purpose. That data could be obtained as a result of the accumulation and processing of information coming in from spacecraft.

The capabilities for remote measurement of hydrometeorological parameters at any point on the globe, and the rapid transmission of that information to information processing locations together with the data obtained by traditional methods, also defined the role of space systems in performing this task. One can today obtain information at a frequency of 3—6 hours on the weather situation using the constantly functioning systems and, virtually in real time, transmit it to processing locations and users.

The Military Space Forces, in order to plan the application, storage, maintenance at the required readiness, launch and control of spacecraft, have troops for launch and control, along with arsenals with the corresponding command-and-control elements.

The former (two missile ranges) launch of spacecraft; they are primarily surveillance satellites into low orbits, navigation and communications satellites into highly elliptical orbits, and communications and ballistic-missile launch early warning satellites into geostationary (H = 36,000 km) orbits. They also send scientific satellites into deep space. Specialized engineering and launch complexes with the corresponding check-out equipment, fuel storage facilities, fueling complexes, electric-power supply systems, water supply and other special equipment, as a whole representing a unique and expensive ground complex, have all been created for the pre-flight preparation of the launch vehicles and spacecraft and their fueling. Its reliable operation is possible only provided that equipment is operated by highly qualified specialists, whose training is performed at the Military Space Engineering Academy [VIKKA] imeni A.F. Mozhayskiy in St. Petersburg.

The latter are intended for the control of spacecraft (there are more than a hundred in orbit now) for military, national-economic and scientific purposes, and are responsible for maintaining their operability for the entire period of their active functioning. These troops, for the performance of their tasks, have ground telemetry and control stations (command-and-control stations) scattered across the territory of Russia, as well as offshore stations located on ships. Various programs are transmitted from them for the operation of on-board apparatus. The Main Center of the control and telemetry complexes performs a coordinating role.

Crews are formed at the Main Center and the control stations that know very well the status of the orbital group assigned to them. Officers of the Military Space Forces study the space systems and equipment being created as early as the development stage, take part in the flight design testing and, after they enter service, not only control the craft, but are also able to detect and, where possible using only software, eliminate any problems that arise on board or reduce their effects as much as possible on the performance of the assigned tasks.

The programs for operating the apparatus of a spacecraft, depending on its purpose, can be brought in ahead of time or immediately before their performance virtually in real time. Monitoring of the operability of the spacecraft is accomplished via analysis of telemetric information received from on board. The combat crews are on duty around the clock, and during their shift transmit hundreds of signals where an error in even one of them could lead to the most unfavorable of consequences.

The commander has a staff, ordering directorates, a scientific and technical committee and the corresponding services in order to control the Military Space Forces, organize the employment of space systems and equipment, plan and support the timely provision of the troop with new and modern hardware and provide all-round support for the activity of the troops.

The organizational structure of the Military Space Forces (see figure) provides for the most efficient development and application of space hardware in the interests of the Russian Federation. Russia is, at the same time, the legal successor to the USSR, and it must be concerned with collaborating with the CIS countries in the field of space. All of the former republics of the USSR, and not only Russia, have a vested interest in that activity, since the nations of the commonwealth can realize the potential of the space infrastructure on their territory only through joint space activity.

Effective collaboration in military-space activity by the CIS countries will be largely determined by what options will be selected depending on the political, economic and military situations taking shape. Four basic options are currently being considered:

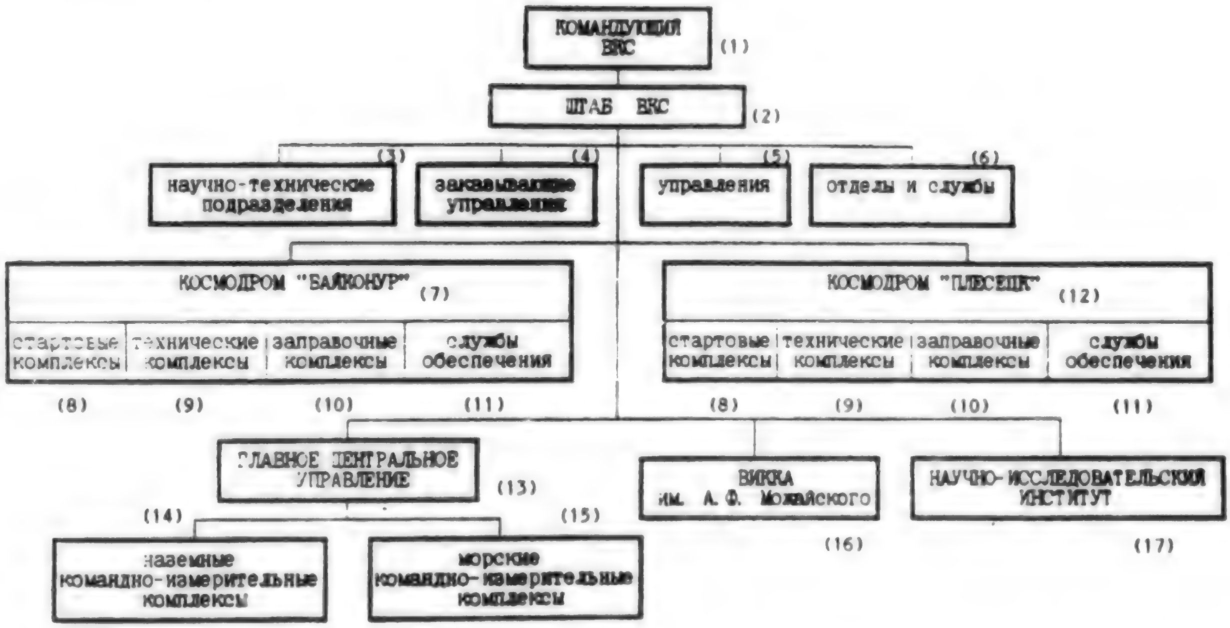
—joint military-space activity of the CIS countries that possess space potential;

—the offering of services by Russia in support of the military and civilian needs of the nations using space hardware;

—the accomplishment of military-space activity in conjunction with all the CIS countries, or some countries taken separately, within the framework of a collective-security treaty; and

—the offering of services by Russia only in the interests of the national economies of nations and the commercial activity of private individuals.

These options, as can be seen, are distinguished by their levels of collaboration. Joint military-space activity of the CIS countries on the basis of multilateral and bilateral agreements is the most promising option. It has



Key:
1. VKS commander
2. staff
3. scientific and technical subunits
4. ordering directorates
5. directorates
6. departments and services
7. Baykonur cosmodrome
8. launch complexes
9. engineering complexes
10. fueling complexes
11. support services
12. Plesetsk cosmodrome
13. Main Central Directorate
14. ground command and telemetry stations
15. offshore command and telemetry stations
16. VIKKA imeni A.F. Mozhayskiy
17. Scientific-Research Institute

objective preconditions for Russia, Ukraine, Kazakhstan, Belarus and Uzbekistan, which possess the largest space potential. The participation of other nations is also not ruled out. The essence of joint activity is the joint development, creation and employment of space systems and equipment, which does not rule out the presence of national space programs as well.

It must unfortunately be asserted that there are still substantial contradictions in this sphere, sometimes contrived and subjective ones.

The Military Space Forces, like the armed forces of Russia as a whole, are currently performing their duties under difficult conditions. There are the generally known difficulties of a political and economic nature, old and new. The new problems are connected first and foremost with the partial destruction of the infrastructure; since a portion of the assets for the launch and control of spacecraft are located on the territory of other nations of the Commonwealth, it is not always possible to coordinate issues that arise in operative fashion. The scientific, technical and production capabilities for the creation of advanced, more effective space equipment and the series production of hardware have decreased.

The solution of problems that arose in prior stages of development of the space forces has become more difficult. These problems include extending the time periods of active functioning of the spacecraft to seven to ten years and increasing their reliability, as well as the difficulties with completing the creation of space complexes and systems that are in the stage of design testing, the replacement of obsolete hardware among the troops for the launch and control of the spacecraft and, of course, work on reusable launch systems.

There is no doubt, however, that the difficulties will be overcome; the sooner they are, the smaller losses Russia will bear.

Russian Reusable Space Launch Systems Under Development

94UM0393B Moscow AVIATSIYA I KOSMONAVTIKA in Russian Nos 9-10, 1993 (signed to press 9 Nov 93) pp 12-14

[Article by S. Umanskiy under the rubric "Prospects of Space Science": "Reusable Space Transport Systems"]

[Excerpt] *The problems of creating reusable means of delivering payloads to Earth orbits give no peace to the specialists in missile and space engineering. And they are not alone. There are those among our readers who are not working in that sphere, but send us their suggestions (I. Konyukhov from the city of Sosnovyy Bor, V. Yelanskiy from Volgodonsk, G. Kotlayraov from Prokopyevsk).*

We are publishing an article by S. Umanskiy on this topical theme. The author has been working for half a century at enterprises where aviation and space hardware is created. He started in 1932 at Dirizhablstroy, where the engineering areas were supervised by the world renowned Umberto Nobile. Then he went to TsAGI [Central Institute of Aerohydrodynamics], where he worked as chief of the fuselage team at the V. Petlyakov KB [Design Bureau], before his arrest. Then, until 1939, he was chief of the armaments team at the KB of V. Belyayev, and took part in the creation of an aircraft with a tailless design. He went, at the suggestion of S. Lavochkin, to the KB newly organized by him as chief of the center plane team, which was incorporated in the LaGG-3 series. He was later the lead designer for the LA-5 with a booster based on a liquid rocket engine developed by V. Glushko. He worked at Plant No. 1 in the town of Podberezye (today the city of Dubna) in conjunction with German aircraft designers starting in 1948, and took part in the creation of a supersonic aircraft (Mach 2) in which the pilot was in a reclining position. He spent 25 years, starting in 1953, at Plant No. 918 (today the Zvezda NPO [Scientific Production Association] headed by G. Severin), where he was developing pressure suits and held positions from lead designer to deputy chief designer.

He has written about space science for many years. His book "Space Orbits" is now coming out from the Prosveshcheniye Publishing House.

Conceptual Framework

Any rocket, with its powerful engines and multitude of complex systems, serves only one time. The launch is made and, whether or not the payload was successfully placed in orbit, it ceases to exist anyway. The situation would naturally be improved in the event of the creation of a launch vehicle that was suitable for repeated launching. The return of its stages to Earth without any serious damage is necessary for that purpose. How can that be achieved? The most promising way is perhaps the development of winged launch vehicles—which have, by the way, already been verified in practice. The wing could be the savior of space rockets in the literal sense of the word, and not only the savior but advantageous as well.

The first attempts to reduce the cost of transport operations were undertaken in the middle of the 1960s in the domestic Spiral and American Dyna-Soar projects. Both projects proposed as the manned spacecraft the use of small, reusable orbital aircraft able to land on airfield runways. The Spiral project was under development at the KB imeni A.I. Mikoyan under the supervision of Chief Designer G. Lozino-Lozinskiy.

The intensive commercialization of freight traffic into space is causing it to double every ten years. An analysis of the masses of the payloads being launched shows that in 90 percent of the cases, they are within the range of hundreds of kilograms to 10—12 tonnes. The plans for the new, reusable means of launch are oriented toward just such loads. The creation of expensive launch complexes and the allocation of considerable territories for the safe fall of launch-vehicle stages, moreover containing residual toxic fuel components, are not required for the operation of an MTKS [reusable space transport system]. The use of returnable stages will make it possible to reduce the pollution of near-Earth space, which is very important since every possible type of residue from space hardware poses a substantial hazard for operating satellites. The new class of spacecraft possesses other advantages as well. They include a high frequency of launches thanks, to the simplification and reduction of the time for interorbital and pre-flight preparation, the placement of a payload in orbit at virtually any inclination, since launch is possible from any geographic latitude, increased reliability of launches, the possibility of launching at any time of day, emergency assistance to cosmonauts in orbit, and the delivery of freight and passengers to any point on the globe within two or three hours.

Reusable transport systems of some types could be created in the next few years, and would provide a significant reduction in launch cost. The high unit cost of delivering payloads into orbit is the principal factor hindering the development of space science. The further progress of space engineering depends on the extent to which it is reduced. Several MTKS projects have been started in Russia, and studies at the level of preliminary designs and engineering proposals exist for a number of them. The Energiya NPO, Raduga MKB [Mechanical Engineering Design Bureau], Molniya NPO and the NPO imeni A.N. Tupolev are all occupied with this. Foreign projects include the French Arienne-5/Hermes, the German Senger and the X-30 space aircraft being developed in the United States.

It must be said that the MTKSs being created cannot compete with the large, vertically launched launch vehicles that put payloads of more than 10—15 tonnes into orbit.

Engines

Space flight vehicles are currently put into orbit by rockets fitted with thermochemical rocket engines using liquid or solid fuel (combustible and oxidizer). Liquid-fueled engines (ZhRD) use kerosene, hydrazine, dimethylhydrazine, alcohol or hydrogen as the combustible, and oxygen, nitric acid or nitrogen oxides as the oxidizer.

The greatest specific thrust impulse is created by engines operating on liquid oxygen and liquid hydrogen. The mass of the oxidizer is approximately five times the mass of the combustible therein. The mass of the fuel as a whole constitutes about 90 percent of the launch mass of a rocket fitted with ZhRDs.

The use of atmospheric oxygen could obviously provide a large economy in takeoff. This would make possible an appreciable reduction in the quantity of it in the tanks of the rocket. But then the use of turbojet (TRD) and ramjet-rocket engines (PVRD) would be required to a certain altitude.

A TRD provides thrust at launch and in flight up to speeds of approximately one kilometer/second (Mach 3). They are not employable above these speeds. A PVRD creates thrust only in the presence of a certain velocity head created by the oncoming air flow. The flight speed of a craft with a PVRD is limited to Mach 12—15 depending on the design features.

Russian Projects

Those being proposed:

Energiya NPO. The Energiya-M launch vehicle is the latest modification of the Energiya launch vehicle. The same units are used as the first stage, but the quantity is reduced to two. The Energiya-M will be able to place a payload of up to 35 tonnes into low near-Earth orbit. The launch mass is 1,050 tonnes. The Energiya-M launch vehicle is being studied with reusable units in the first stage, using winged unmanned craft that automatically return to the launch site.

The Raduga Mechanical Engineering Design Bureau. A project has been developed here, in conjunction with other enterprises, and a program is being implemented for the creation of the Burlak space system. It will be composed of the Tu-160SK supersonic carrier aircraft, the Burlak launch vehicle and a telemetry and control complex based on the Il-76 SK aircraft. The launch aircraft can deliver the Burlak rocket to any launch location within a radius of 5,000 km from the airfield from which it departs, and launch it at an altitude of 14 km at a speed of up to 500 meters/second. The Burlak two-stage launch vehicle is fitted with a ZhRD with a thrust of 46 tonnes in the first stage and 10 tonnes in the second stage. The first, after utilization, descends to Earth by parachute, and the second burns up in the atmosphere. The maximum payload that can be launched into an orbit of 200 km is 1,100 kg with a launch mass of 27 tonnes. The plans for the further development of this project envisage fitting the first stage with a hypersonic air-breathing engine. It descends after separation for repeated utilization. This system, which has received the name Burlak-M, will make it possible to increase payload mass by one and a half times.

The Molniya NPO. Interest was displayed at the 40th Congress of the International Astronautical Federation (IAF) in 1989 in a project presented by General Designer G. Lozino-Lozinskiy. He proposed a winged system with a total mass of 560—600 tonnes, in which the first stage would be the powerful Mriya aircraft, and the second an orbital aircraft with a mass of 250 tonnes with an external fuel tank. This air/space system will make it possible to put into an orbit, with an altitude of 200 km, a payload with a mass of up to seven tonnes in a manned version, eight tonnes in an unmanned version and 17 tonnes in a freight version. Everything except the external tank is reusable. What is the advantage of this air/space system (AKS)? First of all, it is not comparable with the Space Shuttle or the Buran in operability. It can be launched from airports adapted for the operation of passenger aircraft, and deliver more than 50 people and cargo to any point on the globe. Second, a flight of the AKS costs about one tenth the launch of a Space Shuttle.

The ANTK imeni A.N. Tupolev. An original project is being developed here for a single-stage air/space aircraft (VKS). The realization of this project will make it possible not only to create a fundamentally new class of flight vehicles, but also to assimilate the advanced technologies that will determine the level of technical development of the country at the beginning of the 21st century. The VKS, taking off from an airfield, will support the delivery of a payload into orbit at a substantially lower unit cost. Its creation will become possible, however, only based on new achievements in materials science, technology, engine and instrument building, and the widespread application of computers.

The large expenditures for the development of the VKS will be profitable *a priori*. Their profitability lies not only in the sharp reduction in the unit cost of delivering cargo into orbit, but also in the development of new technologies in the process of implementing the project.

The VKS should have a fuselage with a tapered nose section, a delta wing, length of about 60 meters, wingspan of 14 meters and maximum takeoff mass of 70 to 90 tonnes with a payload of 8 to 10 tonnes being placed into an orbit of 200 km in altitude. The power plant will include engines of three types: a TRD for takeoff and acceleration, a ramjet and ZhRD for reaching orbit, executing maneuvers in orbit and braking when leaving it. The manufacture of an experimental model of a craft that will make flights at a speed of Mach 6 is proposed in the first stage, and then the phase of ta the full-scale prototype supporting the reaching of near-Earth orbit. [passage omitted]

Same Causes Seen To Persist for Air Crashes, Incidents

94UM0393C Moscow AVIATSIYA I KOSMONAVTIKA in Russian Nos 9-10, 1993 (signed to press 9 Nov 93) pp 22-23

[Article by Major-General of Aviation Ya. Yanakov under the rubric "Flight Safety: Experience, Analysis, Problems": "From Square One Again?"]

[Text] *Flight operations, despite all types of preventive measures, unfortunately always entail accidents and crashes. The specturm of their causes is very broad. All of*

the cause-and-effect links are very difficult to determine unequivocably even in the deepest investigation of a flight accident (LP).

It is unfortunately not proving possible to eliminate the repeated nature of one and the same causes in the work to prevent LPs year after year. The directorates of the larger formations and units, the Air Forces high command and the Aviation Flight Safety Service of the Air Forces of the Russian Federation blame the lower echelons for this. A stream of documents and requirements goes out, but the situation has not changed.

The content of the documents governing flight operations does not always correspond to the amount of essential knowledge.

Individuals among the flight personnel commit errors, as a rule, not because they work badly on themselves and do not want to raise their professional level, but often owing to too little work experience and a lack of special literature.

The pilots, members of the flight operations groups (GRP) and commanders at all levels frequently do not have textbooks and reference materials that spell out, on a scientific basis, concrete areas of activity to ensure flight safety in organizing and controlling them, performing flight missions and getting into emergency situations.

The supervisory and flight personnel, utilizing the results of practical activity and the mutual exchange of experience in organizing and executing flights, of course know the answers to the vitally important questions that are not found either in textbooks or in documents. This experience, however, is not summarized and made systematic, and is of a fragmented nature. The information needed by aviation specialists is thus not fully distributed in the aviation units, which in turn does not allow them to determine the general features of the organization and performance of flights by types of flight training.

The corresponding bodies—the directorate of combat training, the higher educational institutions, the Flight Safety Service, the scientific centers and institutions—are called upon to occupy themselves with these issues. They are proving difficult to resolve, however, even though there are more than enough opportunities and rights.

The next LP occurs, and its investigation begins virtually from square one without any regard for the dozens of similar instances that have occurred before. The result, in the best case, is passed along to the commanders, pilots and other aviation specialists, but for some reason does not become the subject of profound analysis and study; conclusions are accordingly not drawn and practical recommendations are not devised, the appropriate changes and amendments to guiding documents, teaching materials and instructions are not made, and systematized and summarized materials on the causes of LPs are not accumulated. The final materials from investigations have the look of a legal document with the mandatory recording of all prescribed procedures, and are characterized by a methodological thrust only to the slightest extent.

The broad range of issues considered during the course of investigating an LP unfortunately does not become the subject of further scientific research. When the circumstances and causes of LPs are passed along to the personnel, they are filled, as a rule, with wording and conclusions that set the teeth on edge such as "unsatisfactory organization of flights," "errors in piloting technique," "lack of discipline...," and details and nuances that are of professional interest are not always considered.

The sophistication of contemporary aviation hardware in the Air Forces—the Su-27, the MiG-29—has brought about a paradox: the content and quality of development of the flight operations manuals (RLEs) for those aircraft and the methodological references for piloting technique and weapons delivery have declined sharply. But these are, after all, the primary documents by which the pilots prepare for flights and carry them out, and the aviation hardware is serviced. Why the RLEs have begun to be published in an amount that is not sufficient to train crews at the 1:1 level is also incomprehensible. Even this poor quality flight documentation is thus lacking in the units to support everyday training as a result.

Some of the LPs in the Air Forces, as is well known, are of a repetitive nature. A pair on IFR, for example, was at the stage of penetrating the cloud cover upward during takeoff. The wingman, accelerating the aircraft while entering the clouds, lost his bearings and stalled. The methodological reference on piloting technique has an analysis of three methods of penetrating cloud cover that covers just a third of a page, and the conditions for the use of this or that method, the technique for organizing and executing the flights, possible pilot errors and actions to rectify them, and questions of the interaction of the leader and wingman are all not covered; there are thus no recommendations for the GRP specialists. LPs and dangerous preconditions to them that have occurred at this stage of a flight are not considered, recommendations are not given to prevent them, and pilot actions when getting into an emergency situation are not provided.

Pilots make errors principally in determining the lower edge of the cloud cover and the selection of the method of penetrating it.

The penetration of cloud cover when its lower boundary is lower than an altitude of 200 meters or in a closed battle formation (depending on the type of aircraft) with a breakoff at an angle of 15° leads to the fact that after the takeoff of the crew, while entering the cloud cover they do not have enough time to retract the landing gear, go over to the stipulated flight mode (in speed, engine RPM and angle of climb), or for the wingman, moreover, to make the breakoff at the assigned angle, go over to instrument flying and take his assigned place in the

formation. The leader does not have the opportunity to become visually convinced of the readiness of the wingman to enter the clouds. When entering the clouds in non-stipulated mode, when the wingman is forced to divert his attention from flying by instruments to look for the leader, an accident situation is created.

We find in virtually no document, however, a technique for determining the flight conditions for penetrating cloud cover by a pair or in a closed battle formation. There are also no recommendations for the commander to organize their execution.

Pilots on ferry flights, not knowing the actual conditions and not prepared to penetrate cloud cover in closed battle formations, are often afraid of getting separated from the leader or not finding him. The commanders organizing these flights at the intermediate airfields, considering them to be "somebody else's," do not devote the proper attention to preparing them. The result, as a rule, is an LP.

Some positions of the RLE are set forth in non-specific fashion, in general form or in "little print," especially for actions in special cases in flight. When LPs occur and specialists find the true causes for their occurrence, it then becomes clear what this short suggestion or number lost in the overall stream of information signifies.

Flights were being made on MiG-29 aircraft with enrolled personnel at one of the airfields of the Borisoglebsk Training Center in April of 1993. Senior Lieutenant A. Korolev, after putting the landing gear lever in the down position, reported that the right strut had not come down, the green light for lowered position was not on, and the red—for intermediate position—was on continuously. The pilot, according to instructions, should have made several tries at lowering and, if the strut would not go down, try to lower it using alternating G-forces. If that was not successful, he needed to retract the landing gear, lower the forward strut on an emergency basis and make a landing on dirt.

What to do? The dirt (back-up) runway was not ready, owing to the frequent precipitation and the presence of mud. The flight operations officer, Lieutenant-Colonel V. Druzhinin, made the decision for a pass over the start area. He and his assistant observed visually from the ground that the landing gear struts were in the lowered position. Regimental commander Lieutenant-Colonel V. Strelnikov gave the OK to make the landing. The flight ended fine. The reason for the false actuation of the signal was the overheating of a fuse. There was also no indication that a failure to lower or intermediate position of the landing gear struts should be confirmed by an observer from the GRP on the ground.

The regimental commander made an error, and he would have been the culprit in an LP, since he legally violated the requirement for the supervision of the flight servicing of the aircraft.

Other officials proposed making a landing on the fuselage and the forward strut on an artificially surfaced runway, watering it down ahead of time to ease the landing (reduce friction). They would have formally been right, but there could have been a different outcome. This incident was considered routine, and no one made any additions or changes to the manual. It will be too bad if it is remembered when a similar situation ends in a flight accident.

The correct organization of flight control is a very important task in ensuring accident-free flight operations. The annual statistics on LPs show how problematical the quality of its resolution remains. The creation of flight operations centers (TsRP), at first glance, eased the work of the command personnel. Officers from the regimental and squadron levels in line units, at flight educational institutions and training centers, who used to have to devote the lion's share of their duty time to flight operations control, now received the opportunity to be engaged in full-fledged flight, instructional and preventive work. Also a positive is the fact that the regimental commanders were also given the duty of supervising flights, with the aim of a more professional understanding of the system of supervision and control of flights and the correct organization and performance of the training of flight operations officers and officers at the GRPs.

One cannot, however, omit the shortcomings of this system, which have an extremely negative effect on ensuring accident-free operations by the flight control elements.

First of all, the centers were removed from the air regiments and artificially separated from the unified process for the organization, preparation and performance of the flights. It was felt, for some reason, that a chief of a TsRP independent of the regimental commander would ensure the quality and safety of flights better than the regimental commander himself, who bears legal responsibility for the whole set of operations being performed. Recurrences of an old disease had an effect, wherein it was felt that high exactingness, strictness and administrative measures could solve the problem of flight safety. One thing was not taken into account—that the level of the regimental commanders and their deputies, their professional outlook, work experience and the responsibility placed on them in accordance with the requirements of the documents, were much higher than the chief of the TsRP, the regular flight operations officer or the other officers of the GRP.

The removal of the TsRP from the regiment has led to a decline in the professional training of the GRP officers and the removal of responsibility from regimental officers for training (navigational, engineering, simulator, flight and methodological, among others) whose performance requires work involving a broad circle of specialists that are not present at the TsRP but are present in the regiment.

The inclusion of the TsRPs in the regiments (if there are two regiments based at an airfield, it would be expedient for each to have a TsRP able to support the operations and alert duty on assigned days of the week) would restore the unified system of organization and performance of flights.

Second, the control of flight operations is supported by two elements that are separate from each other—the command post (KP), which is part of the regiment, and the TsRP, which is delineated as an independent unit. The GRP is composed of officers from both units. The officers from the TsRP (from the landing zone or inner approach area) may be reassigned to the KP, and vice versa. This separation was also made artificially. Neither the KP nor the TsRP can get by without the other, either in peacetime or in wartime, at the regimental level.

It would thus be expedient to create a unified system for the control of flight operations in the regiment under unified command.

The training of officers for flight control is being reconsidered as a whole in connection with the reorganization of the system of officer training. The question of the training of specialists able to perform duties at the primary posts of the existing control systems, including the regional centers (RTs) of the ATC system in interaction with the ATC bodies of civil aviation, is being resolved therein. The merging of the KP and the TsRP in the regiments into a unified element would thus make it possible to improve considerably the control of aviation units when performing combat-training tasks.

Third, the start-up of the TsRP has increased considerably the number of officer positions in the system of flight control operations, including flight operations officers. The principle of staffing the RP with pilots no longer flying, primarily the deputy commanders of the air squadrons and up, who as a rule had experience in flight control and flight operations in the same type of aircraft that is in service with the regiment, had existed before. Flight operations officers cannot be trained without the creation of a streamlined system for their training and emergence under conditions of the conversion of frontal aviation to contemporary types of aircraft. The transition to base training of officers for flight control operations with a five-year training period at the branch of the Kachinsk School in Yeysk will make it possible to raise the level and quality of the training of graduates for the successful assimilation of the primary positions in the GRPs in the long run. The level of their knowledge will make it possible to occupy the standard positions at RPs and chiefs of TsRPs in the future, with the preservation of the principle of continuous training in the units, and the conduct of training and retraining in skills-enhancement courses at the corresponding higher educational institutions.

The selection of specialists for the TsRPs, for this program to be realized, must be performed as much as possible from among pilots no longer flying, with their subsequent retraining for the performance of specific duties. The selection and training of RP personnel, when this cannot be done, is best performed from the GRP groups.

It is obvious that many of the flight operations officers today are not fully prepared for the control of flights, especially in emergency or non-standard situations. Crew members Captain V. Danilenko and Major O. Sasov, after takeoff in a MiG-23 UB aircraft at the Totskoye airfield of the air forces of the Moscow Military District on 4 February 1993, heard a banging in the compressor area, and the thrust and RPMs of the engine decreased, after they turned off the afterburner and reduced engine RPM at an altitude of 600 meters. The pilots did not lose their heads—they set the engine control level at maximum (the RPM were restored), gained altitude to 2,800 meters and reported to the RP. They received no intelligible commands from them, however. The regimental commander, Colonel N. Lysachin, who was in the air at the time, ordered the crew to turn 180° and make a landing approach on a heading back to the airfield. The banging was renewed during the process of turning, and the "Engine Overheat" light came on. The crew cut off the engine at the order of the regimental commander. At 1,600 meters they made a restart and landed. The RP, being unprepared for action in this situation, began to complicate the situation with unnecessary requests and incorrect commands. Colonel Lysachin, assuming control, was able to rectify the situation. But regimental commander, after all, cannot always be on the scene, and is not always able to grasp the dynamic of what is happening and orient himself properly. Only the RP, controlling the flights continuously, and if it is prepared, can render skilled assistance to a crew, especially under conditions of a rapidly developing emergency situation.

The cause of the failure, as was ascertained later, was the loosening of a nut holding the first stage of the compressor owing to the destruction of the locking pin.

The lack of preparedness of flight operations officers for action in emergency and complex situations has unfortunately become a common phenomenon. Commanders at all levels, and first and foremost the commanders of regiments, must devote more attention to questions of the training of officers in the flight operations control elements, and create a genuine school for the education and training of control specialists able to find the correct solutions in difficult situations and become true helpers to the pilots.

Articles Not Translated

00000000 Moscow AVIATSIYA I KOSMONAVTIKA in Russian Nos 9-10, 1993 (signed to press 9 Nov 93)

[Text]

Russia-France: Collaboration in Space C2

Russian Manned Space Flight (K. Lantratov) 4-7

Grocer Brothers (A. Loskutov) 8-9

The Space Advent of Engineer Isayev (F.V. Tsetlin) 10-11, 15

The American 'Apollo' (S. Shamsutdinov, I. Marinin) 16-19

The Golden Mean? (S. Volkov) 20-21

More Questions Than Answers; Education Does Not Suffer Formalism (S. Valchenko) 26-27

Analyzing a Flight (Yu. Popov) 28-29

The T-4: A 'Russian Miracle' or Technical Adventure? (V. Yakovlev, G. Grishayeva) 30-35

Heavy Helicopters: Mi-6 and CH-53E Super Stallion (M. Pestrakov, N. Yakubovich) 36-37

Trained in the Near East (V. Babich) 38-39

The 'Narkom' Fighter (V. Deberdeyev) 40

The 'Voisenne' (V. Zaretskiy) 40-41

Hunting the 'Hunters' (G. Bayevskiy) 42-43

Duel (S. Ruban) 44

My Flight Log (A. Markusha) 45-46

Publication Data

94UM0393E Moscow AVIATSIYA I KOSMONAVTIKA in Russian Nos 9-10, 1993 (signed to press 9 Nov 93)

[Text]

English title: AVIATION AND COSMONAUTICS

Russian title: AVIATSIYA I KOSMONAVTIKA

Editor: V.V. Anuchin

Publishing house: Voyenizdat

Date of publication: September-October 1993

Signed to press: 9 November 93

Col-Gen Kot on Future of Air Forces

94UM0394A Moscow AVIATSIYA I KOSMONAVTIKA in Russian Nos 11-12, 1993 (signed to press 10 Sep 93) pp 2-3

[Interview with Colonel-General Viktor Sevastyanovich Kot by an AiK correspondent under the rubric "Topical Interview": "In the Interests of Combat Readiness"]

[Text] *The summer training period has come to an end in the armed forces. And by tradition the results have been summarized, the unresolved problems discussed, and new thresholds have been planned among the troops. All of this pertains to the aviation collectives as well. Do they have opportunities for a further rise in the level of professional mastery, combat readiness, organization and order? The first deputy commander-in-chief of the Air Forces, Hero of the Soviet Union and honored military pilot of the Russian Federation Colonel-General Viktor Sevastyanovich Kot answers these and other questions from our correspondent.*

[AiK] Our nation is experiencing a difficult period in its history. The profound transformations in society cannot help but be reflected in the state of the armed forces. The readers of the journal are thus not uninterested in learning how you assess the situation that has taken shape in the Air Forces today. How is it affecting the process of combat training for the fliers?

[Kot] The Air Forces are being built in stages, in accordance with the conceptual framework for the reformation of the armed forces of Russia that has been devised. We performed a careful analysis of their actual state and an inventory in 1992, became familiarized with the organizational structure, and clarified the procedure for the withdrawal of aviation units from the countries of the near and far abroad.

In reforming that "portion" of the Air Forces that came to Russia after the division among the states of the former USSR, we concluded that they should be comparatively small in force composition, well equipped with contemporary aviation hardware, have an efficient system of command and control and support and an intelligent structure for the accomplishment of rapid maneuvering of forces to threatened sectors, in order to perform the tasks in accordance with the purpose of the Air Forces and the doctrine that has been adopted. We impart particular significance herein to increasing the mobility of aviation, as testified by the Voskhod-93 experimental exercise that was successfully conducted on the scale of the entire Air Forces in May, and which has already been described in the pages of the journal.

The conversion of the higher military schools for pilots and navigators of the Air Forces to a five-year course of study for cadets, a focus on their acquisition of fundamental knowledge in both general and special fields, continuous base flight training on trainer aircraft for 14—16 months with later conversion training of graduates on combat aircraft at the air training center—all of these measures, in my opinion, will make it possible to man the line units, training regiments and squadrons with first-class aerial warriors.

The problems of the formation of aerial forces in the principal strategic sectors and infrastructure development in new basing areas for aviation formations and units, both being withdrawn onto the territory of Russia or being newly created, and the maintenance of the required level of their combat and mobilization readiness and fighting ability remain most acute for the Air Forces. Their resolution depends on the level of equipping of the Air Forces with aviation and special hardware, flight, engineering and technical personnel, junior aviation specialists, the functioning of the system of command and control, and the sufficiency of logistical resources. And whereas just a little over a year ago, when the process of the formation of the Air Forces of Russia had only just started, the state of combat readiness of their units, certain larger units and even whole formations was deemed by us to be almost catastrophic, this year, despite the great difficulties with logistical support for the troops, we have been able to achieve a level of training of flight, engineering and technical personnel commanders and staffs at all levels that makes it possible to fulfill the mission entrusted to the Air Forces. This conclusion can be drawn from the results of the major command/staff and experimental exercises that were conducted on the scale of the entire Air Forces.

[AiK] Questions of maintaining combat readiness, however, are currently considered in any event through the lens of the intelligent utilization of the budgetary appropriations allocated to the Ministry of Defense of the Russian Federation. Is that approach justified under the conditions of inflation, when the discussion concerns the defensive capability of the country?

[Kot] The principle of strategic military parity was inherent in our former military doctrine, and its achievement was considered the restraining factor and principal criterion for evaluating the level of national security. All military requisitions, including for the Air Forces, were satisfied completely by the state in most instances, and it is moreover no secret that it was to the detriment of the national economy, which also led to the excessive militarization of the country's economy with all of the consequences arising therefrom.

The review of the conceptual framework for the security of Russia, in connection with the changes in the geopolitical situation in the world, is testimony to the fact that the likelihood of the outbreak of a world nuclear or conventional war is significantly reduced today. Certain groups of general-purpose forces are sufficient to restrain an aggressor from unleashing regional and local wars, as well as to avert armed conflicts in Russia. The building of the armed forces of the Russian Federation, including the Air Forces, is indeed proceeding from those postulates. Demographic and economic factors are the defining ones under today's conditions.

We are faced with the problem of financial support for the armed forces today as never before, owing to the

crisis that Russia is experiencing. Whence it follows that the resolution of issues of maintaining combat readiness must be considered, one way or another, through the lens of the intelligent utilization of the budgetary appropriations allocated to the Air Forces. And it is no accident that the leadership of the Air Forces requires of every commander and superior officer the wise expenditure of the funding and material resources allocated strictly for their assigned purposes, their economizing and steps to maintain the hardware and armaments in combat-ready condition.

The main command of the Air Forces is undertaking a series of additional steps for the purpose of obtaining funds to satisfy the social needs of the fliers. We are seeking out our own reserves for financing, along with the expenditure of the state appropriations. These include the sale of obsolete hardware, the making of commercial freight and passenger shipments by military-transport aircraft, and the like.

[AiK] What changes have occurred in the system of manpower acquisition for the Air Forces? Financial support for any enterprise makes no sense, after all, without specific executors and without a well-founded personnel policy.

[Kot] A clear understanding of the fact that the ever worsening problem of replacing the enlisted and NCO personnel in the aviation formations and units can be solved only by transition to a mixed principle for manpower acquisition, under the conditions of the difficult political and economic situation in our nation, has formed among the leadership of the Air Forces in the course of the reforms being pursued in the armed forces. It provides the opportunity to complete military service both under the draft and under contract, as well as to perform alternative service, which will make it possible to create a potential cadre for a professional army in the future.

Service under contract, in my opinion, will become the principal type of service in the system of manpower acquisition for the Air Forces. The experience of the past year has clearly shown that mature, professionally trained people who have served in aviation units before as junior aviation specialists are coming to us for contract service. I would note that we have signed fifteen thousand contracts with specialists in various fields over the first half of this year alone. The necessity of retraining them has arisen. Ways of reforming the training system of the Air Forces have been projected in this regard.

We are ready to accept a considerable number of junior aviation specialists into the Air Forces on a contract basis, but acceptance for contract service has temporarily been halted owing to difficulties in financing the armed forces. The commanders of units and formations, however, should nonetheless not cut off their business contacts with the military commissariats and the public employment centers. I hope that the journal AVIATSIYA I KOSMONAVTIKA will also have its say on this matter, in propagating the romance of martial labor, and elucidating all aspects of it and the advantages of contract service.

[AiK] In speaking of the youth, Viktor Sevastyanovich, are we not forgetting such an important and, I would say traditional, element for Russia as parental mandate or sponsorship? Many of our readers, and first and foremost the mothers of young soldiers, warrant officers and officers, are troubled by the dragged-out, in their opinion, resolution of the question of strengthening legality and regulation order in the army collectives. What can you say regarding the state of military discipline in the aviation units and subunits, and the results of educational work to overcome such negative phenomena as non-regulation mutual relations, ethnic groupings, and conflicts on national or religious grounds in the year that is coming to a close?

[Kot] That is a very legitimate question. My own son is a serviceman, and I share entirely the concern of the parents. I can provide assurances that the high command of the Air Forces, in conjunction with the military procuracy, is devoting the most steadfast attention to these issues, protecting the honor and dignity of fliers regardless of their ranks and positions. We have subjected several command officers whose orders and directives encroached upon the rights of their subordinates to administrative and material liability.

Yes, the guilty have been punished. I would like to note, however, that such violations occur not because our commanders and superior officers are at odds with the law, but rather because their level of legal awareness is too low. That is exactly why the decision was made to organize non-standard legal consultations in each aviation garrison, where the officers and soldiers could supplement their knowledge in the field of military law and obtain information of interest to them. Painstaking and purposeful preventive work in this regard has already begun to yield positive results. Let's look at the numbers.

The number of violations in the Air Forces has decreased by forty percent compared to last year, and the incidents of the death or injury of personnel and desertions have dropped by half; the number of so-called barracks hooligans revealed has declined in the soldier's environment, and conflicts on ethnic grounds have virtually become extinct.

The deputies for personnel work are providing invaluable assistance to the commanders in preventing such violations. The once lost traditions of the entry into formation of the young replacements are being resurrected through their joint efforts, and ties are being set up with representatives of the committees of soldiers' mothers and the public organizations of cities and towns where the new recruits come from.

We are pleased that various delegations and journalists have begun to visit the aviation garrisons more often. By becoming familiarized with the true state of affairs in the

military collectives, they can pass on to their countrymen, and in particular to future defenders of the Fatherland, true information on Russian military aviation today, and talk about the prospects for their development. I am convinced that a little more time will pass than they will acquire sound wings, return to their lost positions and continue the storied traditions in a qualitatively new state. This hope for the better is given to me by my faith in the people with whom I have been fortunate to live on the same ground and fly in the same sky.

Psychological Causes of Improper Pilot Actions Analyzed

94UM0394B Moscow AVIATSIYA I KOSMONAVTIKA in Russian Nos 11-12, 1993 (signed to press 10 Sep 93) pp 4-5

[Article by Candidate of Medical Sciences Colonel V. Kozlov under the rubric "Combat Training and Flight Safety": "The Dangerous 'Scissors'"]

[Text] *The detraining of the flight personnel—with the destruction of skills and abilities that were formulated earlier, and a decline in their professional reliability—is being noted in many aviation units as a consequence of the sharp cutbacks in flying time. Not all of the negative manifestations of this factor, however, lie on the surface, as they say. There are some whose revelation requires a profound psycho-physiological analysis of the causes of flight accidents based on scientific data from aviation psychology and medicine.*

Pilot 2nd Class Captain Yu. Krotov, having fulfilled his combat mission, was returning to his airfield. The fuel remainder in the Su-27, however, proved to be more than the nominal amount, and the pilot obtained permission to circle. The fighter instead tore over the runway, and the pilot began to execute a loop. The aircraft hit the ground coming out of it.

The causes of this flight accident, according to the conclusions of the commission, were the pilot's gross violation of the flight assignment and the requirements of guiding documents and flight regulations, and his own error in piloting technique. A fair conclusion, but it is too early, in my opinion, to close the book on this. Answers have not been obtained, after all, to the fundamental questions of why the pilot went into this most difficult aerobatic maneuver, and whether only calls for the unwavering observance of the requirements of guiding documents and a strengthening of indoctrination work among the flight personnel can be considered a preventive for such LPs [flight accidents].

It was ascertained in the investigation that Captain Krotov had 35 hours of flying time as of the moment of the LP (and that was at the end of the year). Was that a lot or a little? If we take into account data from psycho-physiological research, according to which the optimal flying time should total 150—170 hours, then that is exceptionally little. We will try and analyze how such poor values are reflected in general in the consciousness of the pilot, and whether they act as a regulator of behavior.

These questions are probably being posed for the first time with full justification and urgency. Unfortunately neither physicians nor, the more so, aviation commanders have been asking themselves these questions in any case. It must be understood first and foremost, in order to answer this question, that the pilot has always been, is and will be a person who cannot live without the sky, and the fighter pilot all the more so without dizzying and complex maneuvers in the air. Young people, after all, do not go into aviation, the more so fighter aviation, for the big (?) money or the pretty uniforms. It is namely that irrepressible thirst for the sky, that vividly pronounced need to fly, that constitutes the foundation of the professional and moral-psychological qualities of the pilot and the basis for the flight profession as a whole. Only with such a mindset can one become a true pilot and master of aerial combat. And to understand the actions and deeds of a pilot, to penetrate into his spiritual world, is possible only through an analysis of the motives that guided him there, in the sky. The pilot who is deprived of the opportunity to realize the most burning need—to perform difficult maneuvers—is always ready to take advantage of any opportunity that presents itself. He moreover strives to satisfy this need not partly, but to the full, so as to... experience the feeling of risk. And he who feels that the behavior of the pilot is guided only by flight regulations, even though they are written in the blood of many generations of fliers, is mistaken.

Krotov had been on combat alert duty for a long time in our case. Imagine, then, a pilot who has been kept on "starvation" rations of flying time for almost a year, and who is suddenly given an opportunity, and moreover in front of his colleagues (one cannot forget here such pronounced qualities characteristic of flight personnel as the desire for self-affirmation, and the feeling of personal dignity), to perform a complex maneuver and prove himself.

The pilot obviously did not think about the fact that his prolonged absence from flights with complex maneuvers had led to a certain detraining effect and the destruction of skills and abilities that had been formed earlier, and that the performance of certain maneuvers had become potentially dangerous for him. It seemed to him, as a fighter pilot flying an Su-27 super-aircraft, that he could do anything. And that feeling of confidence was engendered by the lofty mindset for the performance of difficult maneuvers that he was experiencing. A situation arose as a result that is characterized as the dangerous "scissors," where the motivation for professional activity has grown while the level of training has dropped owing to the lack of flying time. It is namely this discrepancy that was one of the basic psychological causes of the LP under consideration.

Another question is also legitimate here—why did the pilot not select a simpler maneuver that he was capable of executing? We will turn to a comparison in order to answer this. Say that a person has been half-starved for a long time, and he is suddenly at a finely appointed table that is

groaning with foods, to any taste—from the ordinary to the most refined. Will he take advantage of the opportunity that presents itself to satisfy the feeling of hunger? Undoubtedly. He moreover eats much and greedily, without thinking of the consequences and, most importantly, treating himself to what he wants the most, precisely the most refined courses. Our pilot behaved likewise—he was given the opportunity of prolonging the flight, and he decided to "eat" the most tasty morsel—a loop. But the same way that a hungry person can suffer from overeating, the pilot frequently suffers from the fact that he allows himself to "eat" too much from his professional flight "ration."

I cannot agree, at the same time, with the opinion of some specialists, who feel that is sufficient to ascertain those who had violated flight assignments before and punish them by keeping them from flights according to the past records. That is not only an incorrect, but even a harmful approach, since it is aimed at suppressing the main thing in the pilot—his high motivation for flight work. One wants to exclaim—don't kill the professional in the pilot on the ground, or else he will then kill himself in the air!

This incident, as well as a careful analysis of the materials from investigations of other accidents and crashes, shows how great the "scissors"—the discrepancy between the high level of motivation of the pilot and his insufficient professional training—really are.

A pilot, for instance, twice committed one and the same error in the performance of an exercise. The commanders, however, without having ascertained the true cause of what had happened, imposed restrictions as a "rebuke." The exercise was planned again for literally the very next flight shift. The desire of the pilot to run through successfully the element of the assignment in which the error had been made in the previous flight was entirely understandable, was very great, but the level of preparation remained the same as before. It is no wonder that the pilot again made the old mistake and, in striving to rectify it, made a new and more dangerous one that was indeed the cause of a flight accident.

It also happens that a high level of motivation does not permit the pilot to refrain from continuing a flight assignment, even though the situation taking shape reduces considerably the likelihood of its successful completion. A commander, instructing a pilot before a sortie to perform a set of exercises with advanced aerobatic maneuvers, emphasized the direct link between the quality of his work in the air and his further service career. The level of motivation was raised exceptionally high thereby. A situation arose in flight, however, where the sequence of practicing the aerobatic maneuvers had to be changed. The high motivation created before the flight for its successful completion did not permit the pilot to refrain from the decision made earlier, and the result was a flight accident.

Just such dangerous "scissors"—a growth in the motivation for professional activity, and a reduction in the level of training owing to cutbacks in flying time—have taken shape in aviation today. Every pilot needs optimal annual flying time of 150—170 hours in order to achieve flying mastery and realize himself to the full extent.

I have no doubt of the necessity of the strict observance of flight regulations and the requirements of documents governing flight safety. I would note nonetheless that the prevention of LPs should include, aside from everything else, a psycho-physiological analysis of the nature of that type of violations. It is essential to understand first and foremost the role of motivating factors in the activity of the flight personnel, as well as to pass on to every pilot the fact that he must know how to control his motivations, however difficult that may be.

Development History of Tu-22 Bomber and Modifications

94UM0394C Moscow AVIATSIYA I KOSMONAVTIKA in Russian Nos 11-12, 1993 (signed to press 10 Sep 93) pp 11-15

[Article by S. Rigmant and A. Magashchuk under the rubric "Domestic Aviation Hardware": "The Tu-22: The First Series-Produced, Long-Range Supersonic Aircraft"]

[Text] An aircraft with a unique configuration—a long fuselage, a highly swept wing, and two powerful engines at the base of the tail on both sides of it—first went up into the sky 35 years ago.

The work on this aircraft, which later received the designation of Tu-22, had been launched at the beginning of the 1950s. The preliminary work to formulate the look and seek out the optimal designs for advanced long-range bomber aircraft and the carriers of a new type of weapon—air-to-surface missiles capable of significantly exceeding the speed of sound—had begun at the A. Tupolev OKB [Experimental Design Bureau] and TsAGI [Central Aerodynamics Institute] immediately following the transfer of the "88" aircraft (the Tu-16) into series production.

Many types of aircraft, with takeoff masses from several dozen to hundreds of tonnes, were considered in detail in the course of the research. The required thrust of the power plants, the type of engines, their quantity and the locations for installation were all determined. The A. Lyulka and V. Dobrynin OKBs had already designed new and powerful engines with a static thrust with afterburner reaching 10,000—15,000 kgf in the 1950s. New systems of electronics equipment, missile armaments and reliable hydraulic actuators for the control systems also appeared, making it possible to create a new heavy supersonic aircraft.

The analysis of the aerodynamic designs proceeded in two directions—swept-wing aircraft with X = 45—60°, and aircraft that were executed according to the "flying wing" design with a triangular shape in plane view. The preliminary studies were ultimately reduced to three projects at the OKB: the "aircraft 98" frontal supersonic bomber, the "aircraft 105" long-range supersonic bomber, and the "aircraft 108" international supersonic weapons platform.

The first two projects had a swept wing, and the third a delta wing. The 98 and 105 projects were completed with the construction of experimental prototypes, and received further development and incarnation in the series-produced Tu-128 and Tu-22 aircraft, while project 108 remained only in the drawings, as did much other work in those years that was ahead of its time and prepared the ground for a new generation of supersonic Tupolev aircraft, both military and civilian.

The familiar look of the Tu-22, however, did not take shape at once. An attempt was first undertaken for the design engineering of a long-range supersonic bomber based on the 88 aircraft. The unrealized 105 project proposed the installation of four VD-5 or VD-7 engines, placing them in pairs on the vertical plane along the sides of the fuselage of the 88, and a wing with a sweep angle of 45°. But the very first studies showed the clear lack of promise of such an "evolutionary-frontal" approach. New and non-traditional approaches and out-of-the-ordinary design ideas were required. And they were found and successfully realized in the 105 project.

The work was started by government decree in August of 1954, and the preliminary research had been completed and the wind-tunnel testing of models started as early as November. The first variations had much in common in configuration with the 98 and 88 projects, but had increased size and mass. Specific features of the aerodynamics of heavy aircraft in the transsonic and supersonic ranges were studied in the wind-tunnel testing, and various ways of closing the fuselage in the area where the wings were attached were tried out, until the optimal variation designed with a regard for the "rule of areas" was chosen. The highly unconventional look of the 105 aircraft had taken ultimate shape by 1955—a long and compressed fuselage with engines in the tail section and a swept (55°) "clean" wing, with the main landing gear struts, as opposed to the Tu-16, retracted into the fuselage and not into the customary "Tupolev" nacelles. This was to provide, aside from high aerodynamic quality, greater area for wing mechanization and acceptable takeoff and landing characteristics for the aircraft accordingly.

The unconventional configuration of the 105 made it possible to achieve supersonic speeds, but also posed a host of difficult problems in ensuring stability and controllability across a whole range of flight altitudes and speeds. The presence of masses separated along the fuselage, giving colossal moments of inertia, required the introduction of many innovations into the design of the aircraft control systems. An all-moving stabilizer appeared on such a heavy aircraft for the first time (with a back-up altitude control surface), with the drive for the control surfaces accomplished through non-reciprocal hydraulic actuators, with the introduction of spring loaders and retarders. The mechanical control system, however, was retained as a back-up.

The crew of three was accommodated in a common, airtight cockpit. The K-22 seat, specially designed for the 105, ejected downward, which eased the design but markedly restricted the minimum possible altitude for safe emergency ejection. The navigator was effectively deprived of the opportunity of a visual scan, and operated only by instruments for the first time on a bomber. The weapons officer was located behind the pilot with his back to him, and performed the functions of aiming the remote-controlled rear gun mount, equipped with a radar sight. Perhaps the most unconventional was the lack of a co-pilot in the cockpit. This made it possible to install a narrow, wedge-shaped cockpit canopy, which had minimal frontal resistance but also markedly limited the field of view, which combined with the long nose portion of the aircraft demanded enhanced attention from the pilot in takeoff and landing.

The design engineering of the 105 in the variation that was ultimately formulated, with VD-7M engines from the Dobrynin OKB, was begun in 1955. An experimental aircraft was transferred to ZhLIiDB in December of 1957, where refinements and ground testing were performed.

A crew headed by test pilot Yu. Alasheyev carried out the first flight of the 105 on 21 June 1958. The stage of plant testing began. The decision was made in April of 1958, however, to create the 105A aircraft (based on the 105) in two versions, with VD-7M and NK-6 engines. The thrust of the NK-6 engines was to exceed 20,000 kgf, with the aircraft reaching a speed of Mach 2. The first variation was adopted as the principal one after an evaluation of both designs, since the development of the NK-6 engines was still in the design stages. The 105A aircraft was to surpass the initial prototype in combat effectiveness, and become the main one for large-scale series production.

The main landing-gear struts in the 105A again began to be retracted into nacelles on the wing, as on the Tu-16. This made it possible to unburden the fuselage considerably and compress it, simultaneously increasing the capacity of the bomb bay, extremely important for a bomber. The forced reduction in the area for the wing mechanization, however, somewhat worsened the takeoff and landing characteristics of the aircraft. The rear gun mount was altered as well.

Both the customer, the Air Forces, and the leaders of the aviation industry placed great hopes on the new bomber, and the decision was made to launch series production at the Kazan Aviation Plant even before the first flight. The aircraft received the designation Tu-22.

The 105A made its first taxiing in June of 1959, and a crew consisting of commander Yu. Alasheyev, navigator I. Gavrilenko and weapons officer K. Shcherbakov went up on the first test flight on September 7.

The 105A aircraft made six flights according to the program for plant testing. The seventh, on 21 December 1959, ended in catastrophe. Alasheyev and Gavrilenko were killed, and only Shcherbakov was able to eject safely. The caused of the crash was flutter of the altitude control surface, according to

the findings of the commission. This surface was rejected for the series aircraft under construction in Kazan, leaving only the all-moving stabilizer.

The first three series-produced Tu-22 aircraft were flown to ZhLIiDB in July and August of 1960, and an extensive program of flight testing began.

The possibility of utilizing the aircraft in various modifications was envisaged from the very beginning of design engineering on the Tu-22. The Tu-22B bomber, the Tu-22K missile carrier, the Tu-22P jamming aircraft and the Tu-22R reconnaissance aircraft were in series production as early as 1960.

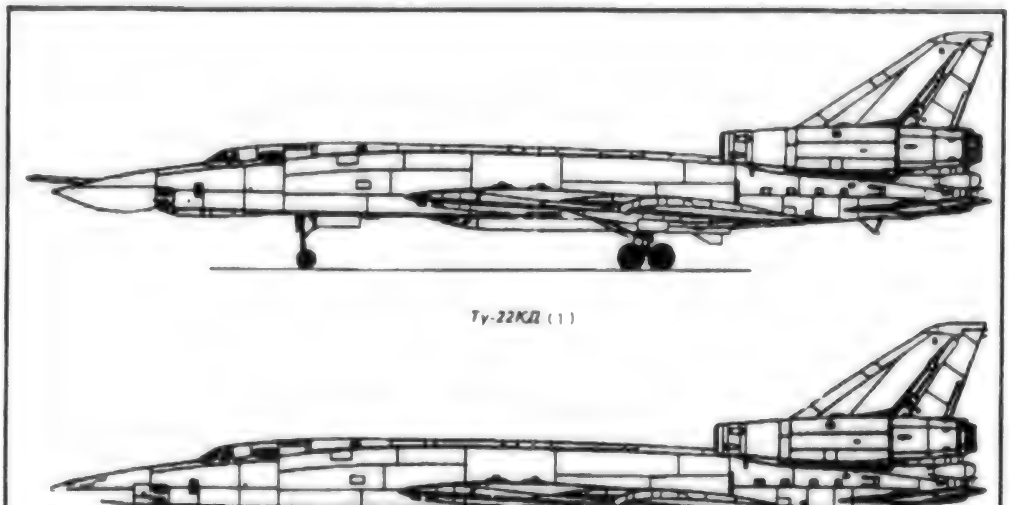
Only ten copies of the Tu-22B were built, and it was not widely employed; it was operated principally in Air Forces training subunits.

The Tu-22R underwent testing in 1960-63. The Tu-22R variation with an aerial refueling system (a boom and drogue system) from 3MS and TU-16N tanker aircraft appeared in 1962. The possibility of refueling, taking into account that the reconnaissance aircraft could be refitted into a bomber comparatively easily, significantly expanded the range of application of the aircraft. All of the modifications of the Tu-22 aircraft were fitted with the refueling system starting in 1965.

The Tu-22K with a single Kh-22 missile and the PN type radar (later models had the Rubin radar) was prepared for tests in 1961. They were delayed, however, owing to the complexity and unfinished nature of the system. State testing of the Tu-22K was completed only in 1967.

The Tu-22P was also series-produced with various versions of electronic-warfare equipment.

The difficulty of training and preparing crews and the impossibility of accommodating an instructor in the cockpit of the aircraft required the emergency creation of a trainer version of the Tu-22. The initial design was reworked, the cockpit was reconfigured, and a workstation for the instructor was placed in the weapons officer's location that was above the cockpit canopy and had its own canopy, which provided an acceptable field of view. A similar design was subsequently used on the Yak-28U, MiG-25 PU and other aircraft.



Key:
1. Tu-22KD 2. Tu-22R 3. TU-22UD

The tactical performance characteristics of the Tu-22U trainer aircraft effectively conformed to the basic aircraft. Only the flight range was reduced somewhat, owing to the reduced fuel reserves.

All of the versions of the Tu-22 were upgraded in the process of series production, the range of applications was expanded, and reliability and flight safety were increased. The first series of aircraft had limitations on the top speed, which corresponded to Mach 1.4, owing to aileron reversal. Leading-edge ailerons were incorporated into the design of the aircraft in 1965, making it possible to realize more fully the speed potential of the Tu-22. The main landing-gear struts were equipped with an elastic suspension that eliminated the landing-gear and wing flutter characteristic of the wing of the Tu-22, and the anti-flutter weighting was simultaneously removed from its wing panels. The new RD-7M2 engines designed by P. Kolesov, with a maximum static thrust of 16,500 kgf, were also incorporated at the same time. The upgrading of the aircraft allowed the series-produced aircraft to reach a speed of 1,600 km/hr. A centralized fueling system that eased and accelerated the servicing of the aircraft system also began to the employed on the Tu-22.

Tactical Performance Characteristics of Some Aircraft in the Tu-22 Family

Aircraft	105	Tu-22 (105A)	Tu-22R	106	145
Stage, year	experimental, 1958	experimental, 1959	series-produced, 1965	design, beginning of 1960s	design, 1965
engines: type, number x thrust, 000 kgf	VD-7M, 2 x 16.0	VD-7M, 2 x 16.0	RD-7M-2, 2 x 16.5	NK-6, 2 x 20—23	NK-144-22, 2 x 22
Length of aircraft, meters	41.921	41.6	41.6	40.2	41.0
Wingspan, meters	23.745	23.646	23.646	23.89	36.7/23.66
Wing area, m^2	166.6	162.25	162	179.2	—
Takeoff mass, tonnes	about 80	84	92	94—99	105
Top speed, km/hr	1,450	1,510	1,600	2,000	2,000
Flight range, km	5,800	4,900—5,850	over 5,000	6,750	4,000—6,000
Effective ceiling, meters	13,600	14,700	13,800	18,000	17,000
Armaments: bombs, normal/maximum, kg	3,000/9,000	3,000/12,000	—	—	—
Missiles	—	—	—	1 x Kh-22	1 x Kh-22
Machinegun-cannon armaments	2 x 23 mm	1 x 23 mm	1 x 23 mm	—	—

The aircraft control system was also refined and improved over the course of series production. The hydraulic actuators were refined, and additional retarders were introduced into the control lines. The creation of the Tu-22, it may be said, laid the foundation for the design engineering of systems for the control of heavy supersonic aircraft, and became a real school for designers.

The Tu-22 was in series production for ten years, and more than 300 of the aircraft were put out until 1969.

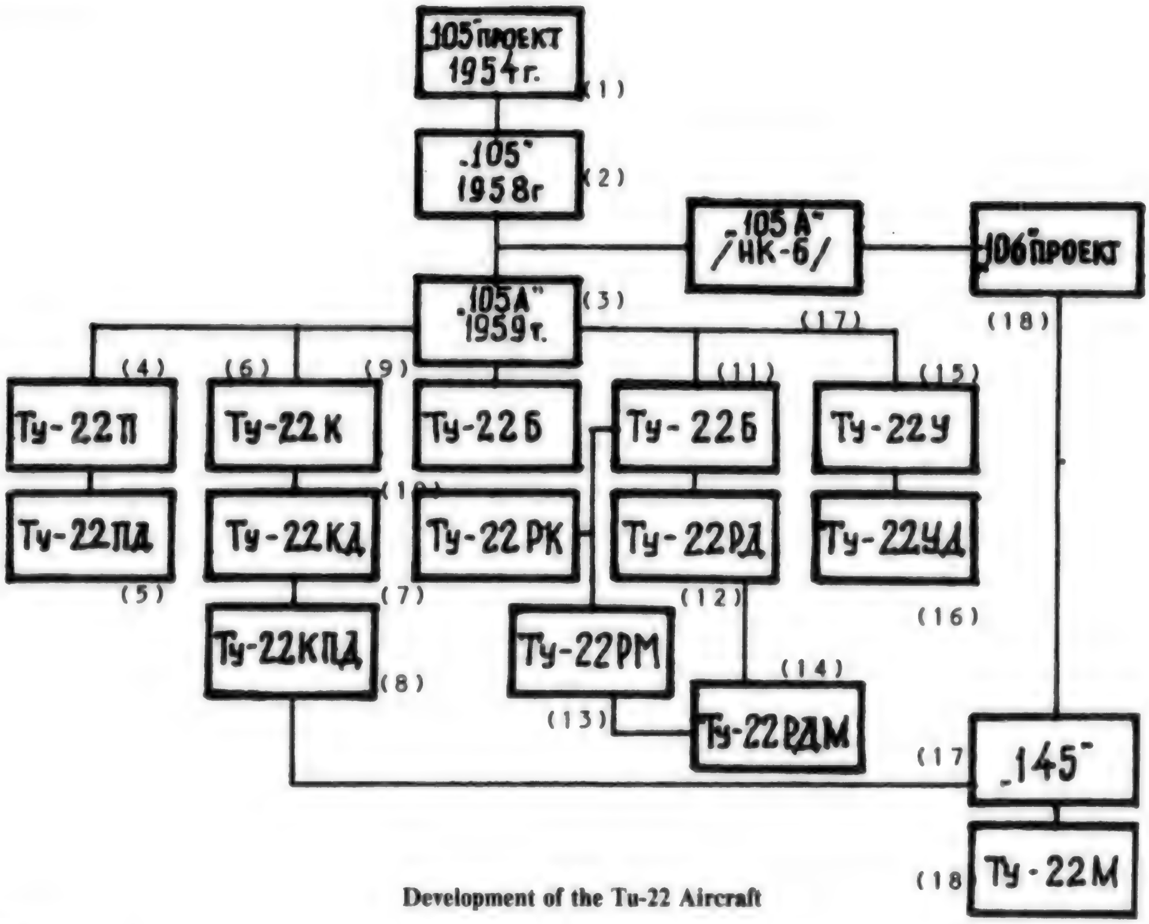
The aircraft was then repeatedly modernized, both at enterprises of the industry and at the repair plants of the Air Forces. The collectives of the OKBs and the series-production plant devoted a great deal of attention to increasing its combat effectiveness. Enormous credit for this belongs to Chief Designer D. Markov, who supervised the work on the 105 continuously right up until January of 1992.

The series-produced Tu-22R reconnaissance aircraft, equipped with new ECM and EW systems, received the designation Tu-22RM. The upgrading did not prove to be sufficiently successful, however, without replacement of the reconnaissance equipment. It was limited to a single aircraft. New and more effective means of reconnaissance began appearing in the 1970s that provided an opportunity to upgrade the field aircraft with a regard for contemporary requirements. The Air Forces received the modernized Tu-22RDM reconnaissance aircraft at the beginning of the 1980s.

The Tu-22R and Tu-22U aircraft were exported to Iraq and Libya, where they were operated under the hot and damp conditions of the tropical climate and displayed high reliability. The Iraqi Air Forces employed Tu-22 aircraft during the Iran-Iraq war, and they demonstrated good combat viability.

All of this confirms that the A. Tupolev OKB created an effective combat aircraft able to carry out the most diverse missions.

And after all, it was also created during a very difficult period for domestic aviation. The "missile boom" at the end of the 1950s threatened to shut down a large part of the aviation programs. Many of the OKBs were switched over to missile and space subjects. During this difficult time A. Tupolev, relying on the experience of preceding work and striving to preserve the aviation subjects at the OKB, proposed the creation of a missile-carrying



Development of the Tu-22 Aircraft

Key:

1. project 105, 1954
2. 105, 1958
3. 105A, 1959
4. Tu-22P
5. Tu-22PD
6. Tu-22K
7. Tu-22KD
8. Tu-22KPD
9. Tu-22B
10. Tu-22RK
11. Tu-22B
12. Tu-22RD
13. Tu-22RM
14. Tu-22RDM
15. Tu-22U
16. Tu-22UD
17. 105A (NK-6)
18. project 106
19. 145
20. Tu-22M

bomber able to perform all of the tasks of heavy bomber aviation in the development of the idea of the Tu-22. The proposal was accepted, and the Tu-22 was improved even further.

The OKB, after an analysis of the 105 and 105A projects with the NK-6 engines, began the development of the "aircraft 106," in which an unconventional "package" engine installation in the tail section, a wing with a sweep angle of up to 60°, new equipment and systems were proposed. The takeoff mass of the aircraft approached 100 tonnes, and the top speed was to reach 2,000 km/hr. The range was increased by 20—30 percent compared to the Tu-22. The NK-6 engines, however, were not refined, and the 106 remained on the drawing board, although some elements of the future aircraft were tested in flight on the Tu-22 flying laboratories.

Work on the "aircraft 145" project—the precursor to the Tu-22M—was the next step by the OKB in the development of the Tu-22. The initial variation of the 145 had the same configuration of engines as the 106, while the NK-144-22 engines themselves were fully realized—they were employed on the Tu-144 aircraft that was created in the middle of the 1960s. A variable-geometry wing was planned for the first time on such a heavy aircraft. The

takeoff mass reached 105 tonnes, and the top speed was proposed at 2,000 km/hr. The crew was increased to four, two pilots and two navigators accommodated in pairs in the airtight cockpit, which simplified and eased the work, especially on long flights. The ejection on the 145 was planned to go up, taking operating experience into account. The rear gun mount was removed, and elements of the EW systems were placed there instead.

The 145 project was reworked in 1967, and the first flight of an experimental copy of the Tu-22M was made in 1969. The history of the creation of the Tu-22M, however, is interesting in and of itself, and goes beyond the framework of this feature.

History and Prospects of the Jet Propulsion NII

94UM0394D Moscow AVIATSIYA I KOSMONAVTIKA in Russian Nos 11-12, 1993 (signed to press 10 Sep 93) pp 39-41

[Article by Russian Academy of Sciences Corresponding Member NIITP Director A. Koroteyev, sector chief Candidate of Technical Sciences Yu. Demyanko and scientific and technical center deputy chief Ye. Kuzmin under the rubric "From the History of Space Science": "The Scientific-Research Institute of Jet Propulsion"]

[Text] The Scientific-Research Institute of Jet Propulsion [RNII] was born in 1933. Its creation was prepared by a whole series of technical, organizational and foreign-policy circumstances. The Group for the Study of Jet Propulsion (Moscow) and the Gas-Dynamic Laboratory (Leningrad) had by that time developed the first prototypes of powdered and liquid rocket engines, rockets and rocket shells with those engines, while the labors of K. Tsiolkovskiy, F. Tsander, I. Kondratyuk and other researchers had laid the foundations for the theory of jet propulsion and the space philosophy of mankind.

During those years Germany, having overcome its economic decline and the inferiority complex caused by the loss of World War I and seeking ways to circumvent the restrictions of the Versailles treaty of 1919, began to develop and create rocket weaponry at an accelerated pace. The leader of the German rocket program was the young designer Werner von Braun.

A sweeping program of accelerated technical rearmament of the Red Army was launched at that time in the USSR. People's Commissar of Defense M. Tukhachevskiy became one of its initiators and leaders. It was namely he who supported the persistent proposals of Sergey Korolev, Ivan Kleymenov, Valentin Glushko and other young rocket designers for the creation of a major scientific-research and design center for the country in this field, and was able to gain the necessary organizational decisions of the government of the USSR. The institute was called NII-1 [Scientific-Research Institute 1] from 1945 to 1965, and then the Thermal Processes NII [NIITP]. It has been on the same premises where it began its work for sixty years (although it has expanded many times over). Its employees have over that time created hundreds of prototypes of rocket engines, rockets, rocket shells and unique instruments, developed the theoretical fundamentals of the processes of combustion, cooling, gas dynamics and the internal and external ballistics of engines and rockets, built dozens of test beds and experimental installations, and wrote hundreds of books and thousands of scientific reports and articles.

The founders of the scientific and design areas at the institute were the eminent scholars, designers and specialists S. Korolev, G. Langemak, V. Glushko, M. Tikhonranov, Yu. Pobedonostsev, A. Kostikov, L. Dushkin, A. Isayev, A. Lyulka, M. Bondaryuk, V. Bolkhovitinov, B. Raushenbakh, I. Gvay, M. Keldysh, G. Petrov, V. Likhushkin, A. Vanichev, V. Avduyevskiy, V. Iyevlev and many others whose names constitute the glory of domestic rocket building.

The Past

We will leaf through the pages in the history of the institute. They are filled with flights of technical thought, the art of design and the dramatic and tragic fates of people.

November 1933. The first Soviet liquid-fueled rocket, the GIRD-Kh, lifts off into the skies. Its designers are F. Tsander, L. Korneyev, L. Dushkin and M. Tikhonravov.

Fall 1937. The first field testing is performed of rocket shells for aviation applications, created under the leadership of G. Langemak. The aviation rocket shells are soon employed by our aircraft in air battles over the Khalkhin-Gol River.

November 1937. The first director of the institute, I. Kleymenov, and Chief Engineer G. Langemak are arrested based on absurd accusations, and are executed two months later. Materials that reveal the genuine essence of these tragic events have become accessible only in recent years.

March—June 1937. The leading designers of the institute, V. Glushko and S. Korolev, were arrested under just such unjustified accusations. They had to go through investigation, court, and prisons, camps and "special" design bureaus for six long years. But they were able to hold themselves together there, and advance the cause of their lives.

February 1940. The first Soviet flight craft with a liquid-fueled jet engine—the RP-318 rocket plane designed by S. Korolev with ZhRDs [liquid-fueled engines] by L. Dushkin—went into the sky.

June 1941. A government decision was made on the eve of the start of war to accept the first salvo-firing rocket systems—the famous Katyushas—into service. The development of the ground rocket artillery began at the institute in 1938. The creators of the Katyushas were a large team of workers from the institute and allied enterprises—A. Kostyukov (supervisor of the work), I.

Gvay, L. Shvarts, Yu. Pobedonostsev, M. Tikhonravov, V. Luzhin, D. Shitov, A. Popov and others. The Katyusha played an enormous role in the Great Patriotic War, and became the foundation of a new branch of service of the Red Army—the Guards mortar units.

May 1942. Test pilot G. Bakhchivandzhi took up the first Soviet interceptor fighter with ZhRDs, the BI-1. It was developed at the KB [Design Bureau] of V. Bolkhovitinov by designers A. Bereznyak and A. Isayev, and the engine (the D1-A-1100) was created at the RNII under the supervision of L. Dushkin.

1944. The first experimental jet engine in the USSR, the S-18, was developed. Its designer was A. Lyulka. After a few years jet engines (as well as turboprops) would thoroughly displace aviation piston engines. The era of jet aviation begins.

In 1946 the government of the USSR adopted a series of decrees that defined a considerable expansion of work in the country on rocket technology, and placed on the agenda the creation of intercontinental ballistic missiles. The institute was immediately included in this sweeping work. Its collective developed the scientific foundations for the design engineering and designing of ZhRDs using high-boiling and cryogenic fuel components for the first ballistic missiles, the R-1 and the R-2.

In 1954-57 work was performed in scientific support of the development of ZhRDs for the R-7 intercontinental ballistic missile and the descent crafts for the launch vehicle version. The creation of the R-7 supported the placement into space of the first artificial Earth satellite in the world, and later the space flight of Yu. Gagarin.

The institute was during those same years the scientific leader in the development of liquid-fueled and ramjet engines for the Burya intercontinental ballistic cruise missile.

At the end of the 1950s the difficult theoretical task of ensuring the longitudinal stability of the missile was resolved. Simple and sound recommendations developed by M. Natanzon made it possible to surmount this barrier that had arisen unexpectedly on the path of development of rocket building.

Work under the supervision of B. Raushenbakh to create the first orientation systems for spacecraft also had begun by this time. Successes in this made it possible to support the launch of the first spacecraft to the moon, photograph for the first time ever and transmit to Earth pictures of its dark side, and to begin systematic study of the planets of the solar system.

1959. A highly economical configuration for ZhRDs with the secondary combustion of producer gas was developed. The first tests in the world of a ZhRD of this type were conducted. This configuration subsequently became the generally accepted one in world missile engine building.

The institute began to resolve another major scientific and technical task in the second half of the 1950s—the employment of nuclear power in space. The first work at the institute, performed under the leadership of V. Iyevlev, became the foundation of a broad program to create nuclear rocket engines (YaRDs) and nuclear power installations.

The first experimental nuclear rocket engine with solid surfaces for heat exchange was created within the framework of this program under the scientific leadership of NII-1. A major test-bed complex (only the United States has anything similar) was built for live testing. Live testing of the reactors and other domestically produced assemblies of the YaRDs was conducted in the 1970s and 1980s. The configuration and design of the domestic reactor for this engine, as acknowledged by foreign specialists, was more progressive and efficient than American ones. Its capabilities are currently being studied intently, both within Russia and outside its borders, in light of the new requirements that are being posed toward space engine building.

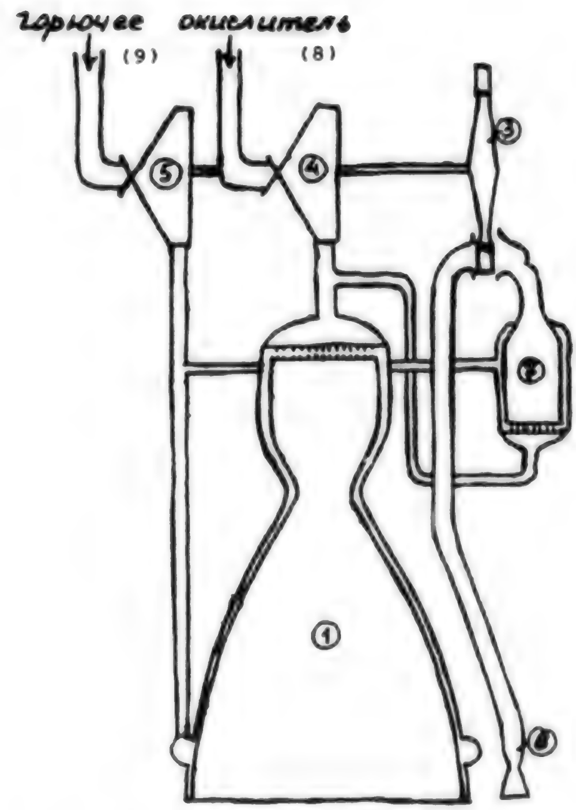
A series of high-pressure and high-capacity plasmatrons for heating air, neutral and inert gases were developed at the institute in the 1960s in order to test the fuel elements of the reactor, and then for a broader circle of tasks. Such installations are employed today in the national economy, and the one at the institute continues to be used for modeling the conditions of entry of descending spacecraft into the atmosphere of the Earth and the planets.

1964. A highly efficient principle of the controlled descent of spacecraft in the atmosphere using a low (K = 0.3—0.4) lift-drag ratio was developed. Methods for computing heat exchange and heat protection in descent were also created concurrently and confirmed by experiments. This made it possible to design a new class of descent craft at the design bureaus to be employed for the first time on the Soyuz craft.

The 1960s were a period of intensive study of the moon by automatic craft for our rocket technology. Recommendations to maintain their thermal conditions were also developed in the laboratories and test beds of the institute.

These same methods were then used to provide thermal protection for the decent craft of the Venera-7 station and the apparatus delivered to the surface of the planet Venus.

We would also note here research into radiation from the Earth and its atmosphere into outer space (a unique piece of measuring gear was created at the institute for this purpose), and the development of instruments for the study of illumination in the atmosphere and on the surface of Venus. The results of recent work made it possible to create a light model of the atmosphere of Venus, and later (1975) to obtain the first panoramic images of the surface of the planet.



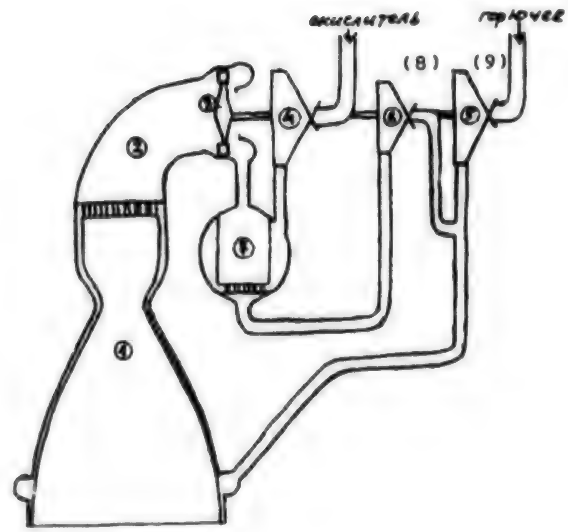


Fig. 1. Basic Diagram of ZhRD Without Secondary Combustion of Gas-Generator Gas; Fig. 2. Basic Diagram of ZhRD With Secondary Combustion of Generator Gas

Key:
1. combustion chamber
2. gas line
3. turbine
4. oxidizer pump
5. combustible pump
6. combustible generator pump
7. gas generator
8. combustible
9. oxidizer

The Present and the Future

One could look long at the affairs of days past, marvel at the sweep and scale of the tasks accomplished, and reflect on the fates of the trailblazers. But it is no less useful to turn our gaze to the institute of today and tomorrow. What is it doing, what problems is the collective working on in our times, difficult in every regard?

The contemporary engine and power installations of missile and space complexes on whose creation NIITP has worked are among the most complex in devising and producing subsystems. The level of the power and mass sophistication, the service lives for active functioning, the reliability and the engineering and economic parameters of the engine and power installations are largely determined by the functional capabilities and engineering and economic efficiency of the missile and space systems as a whole. Typical features of these systems are long (5—7 years) time frames for the development and try-out of new prototypes, which makes it necessary to support a great deal of scientific and technical work in progress. Complexes that are not inferior to foreign ones in their primary criteria and are competitive in world markets can be created in a timely manner only provided that this is so. That is indeed the main concern of the institute.

It must be said that a marked improvement in the characteristics of modern domestic spacecraft for various purposes is an extremely topical task, since our communications, navigational, information and other space complexes and systems are inferior to the best foreign models in some of the most important parameters. This pertains first and foremost to the inadequate productivity of the dedicated gear and the 2—3 times

shorter time of active functioning, which makes it necessary to send up launch vehicles more often than in a case where more advanced satellites are used.

This is why the collective of the institute is seeking ways of increasing the service lives between failures of the engine and power installations, increasing their power to weight ratios, raising the level of their power to mass sophistication and engineering and economic parameters, and utilizing low-toxic and ecologically safe fuel components and working media in the engine and power installations.

The task of determining the realm of intelligent utilization of the systems and units from our military ballistic missile systems (BRKs) being taken out of service for the resolution of national-economic and national-scientific tasks—which will require the performance of the corresponding experimental-design work, including on the engine and power installations and the solid-fuel motors—has appeared in connection with the agreements reached between Russia and the United States on substantial cutbacks in the quantity of BRKs.

The development of missile and space technology in the long term should be one of the primary factors facilitating improvements in productive forces in the main sectors of social production and determining the level of well-being of society—in power engineering and in the production of materials and foodstuffs.

The institute is thus currently developing a conceptual framework for power supply for the Earth from space, founded on the use of solar power and its remote transmission to Earth in the form of optical- and microwave-band emissions. The gradual transfer of a significant portion of power production into space is thus ultimately proposed, and missile and space engineering will be playing a defining role therein.

NIITP is also working on questions of the preservation and restoration of the ozone layer, the removal of especially hazardous wastes from industry and power engineering into outer space, and the clearing of near-Earth space of the remnants and fragments of man-made origins.

The solution of these power-engineering and ecological problems will require a substantial increase in the engineering and economic efficiency of the employment of missile and space hardware, and will entail the resolution of complex scientific, technical, technological and organizational tasks. One of those is the necessity of organizing large—orders of magnitude greater than the contemporary level—freight traffic flows from Earth to satellite orbits, and later, with the full-scale deployment of a system of power supply for the Earth from space, to near-lunar orbits and to the surface of the moon.

This in turn determines the need for the development of highly reliable, economical and ecologically safe launch vehicles, booster units, interorbital tugs and other means of transport, for both one-time and multiple use, and the corresponding engines and power installations. The fuel components and by-products of combustion of the engine installations of the launch vehicles should be the ecologically safest ones, with oxygen as the oxidizer, and kerosene, hydrogen or liquefied natural gases—methane or propane—as the combustible.

The institute has concluded that the use of a fuel (oxygen + liquefied natural gases) that possesses a series of positive qualities, leading in particular to a simplification of post-flight servicing, are exceedingly promising for reusable engine installations for launch vehicles using ZhRDs. Research has demonstrated the expediency of developing multiple-mode ZhRDs able to operate using three-component fuels—oxygen, kerosene and hydrogen, and oxygen, liquefied natural gases and hydrogen—whose application is particularly effective as part of air-space systems.

Air-space systems equipped with combination engine installations utilizing air, including liquefied, in their operation for a considerable portion of their flight should become widespread at the beginning of the 21st century.

NIITP is also occupied with electric rocket engines, possessing high power efficiency in combination with solar and nuclear power installations.

There are projects that still seem too exotic, but we must look ahead as far as possible. The use of substances produced at lunar bases from indigenous raw materials as building and structural materials, as well as fuel components and working media for the rocket engines of moon—near-Earth orbit or moon—Earth transport systems, will be required in the large-scale deployment of a space power system. This makes it necessary to perform research on the utilization of aluminum, silicon and compounds of them as a combustible.

The study of key questions connected with the creation of electro-dynamic mass accelerators that impart escape velocity to objects, which could be utilized effectively as part of a system to remove radioactive and especially hazardous industrial wastes into deep space, is very topical.

The greatest attention (and the corresponding financing) has been devoted abroad in recent years to a search for new rocket fuels using substances with a high power density. Possible ways of obtaining power carriers using substances with atoms that are in an excited state (or radicals) and high-energy metastable compounds are of particular interest in this regard; their use promises the achievement of specific thrust pulses of 10—12 km/sec, which is a qualitative leap in the development of missile and space technology. The freight capacity of a launch vehicle, for instance, increases by 4—5 times therein. That is why our work program should envisage basic and exploratory scientific-research work in that direction as well.

The NIITP has been adapting to the changing conditions of recent years, and is striving to pursue intelligent conversion. The institute, possessing unique experience in scientific-research work in the realm of missile and space engine and power-plant building and a highly skilled workforce across a broad range of sectors of science and industry, is expanding its spheres of collaboration and is successfully working in the interests of enterprises in the extraction and processing sectors of industry. These include electric-power plants, TETs [heat and electric-power plants], oil and gas fields, the production of chemical fibers and much more. Work is also underway on orders from foreign partners.

The intellectual potential of the Scientific-Research Institute of Jet Propulsion should not be lost; it should be utilized in various high-technology realms of space science and the national economy.

Successes, Failures of Zenit Launch-Vehicle Program

94UM0394E Moscow AVIATSIYA I KOSMONAVTIKA in Russian Nos 11-12, 1993 (signed to press 10 Sep 93) pp 42-43

[Article by by Candidate of Technical Sciences Major-General V. Menshikov under the rubric "The Cosmodromes: Rockets and People": "The Difficult Fate of the 'Zenit'"]

[Text] *The history of the "right flank" of the Baykonur cosmodrome is replete with heroic and tragic events. Korolev's famous "seven" put spacecraft into orbit from here to study the planets of the solar systems as well as manned spacecraft, opening the way for mankind into space. There was catastrophe here as well—more than a hundred people were killed, among them Marshal M. Nedelin. A number of promising space and rocket programs were shut down here in times past, and dramatic events are now occurring here with one of the contemporary Zenit launch vehicles.*

The decision to develop this launch vehicle was made in 1976, almost simultaneously with the government decree on the creation of the Energiya-Buran reusable space transport system. And that was no accident. The intent of the designers was to try out the first stage (side units) of the superheavy Energiya class launch vehicle (RN) with the unique and expensive Buran craft as part of the medium-class Zenit rockets before the start of flight testing. The first stage of the Zenit is this largely similar to the side unit of the Energiya in design terms; they have virtually identical sustainer engines, common engineering ideas are inherent in their systems and assemblies, and they were built using a common elemental base. Their design engineering, manufacture and testing were performed by one and the same groups of designers, scientists, and production and test personnel.

The cooperation of the organizations that took part in the creation of this system reflected the close connection of the enterprises of Russia and Ukraine; the lead organization was the Yuzhnoye KB [Design Bureau] (under the leadership of Academician V. Utkin), the first-stage engine was developed and manufactured by Russian enterprises—the Experimental Machine-Building KB (KBEM) and the Polet PO [Production Association], the steering engine of the second stage by the Yuzhnoye KB, and the sustainer engine of the second stage was designed in Russia (KBEM) and manufactured in Ukraine (the Yuzhnoye KB). The control system was created in close collaboration of the Moscow KBs and plants in Kharkov and Kiev, and the ground systems for the preparation and launch of the RN by the Moscow KBTM and plants that were scattered across the entire former Soviet Union. About 40 percent of the 36 principal enterprises engaged in the development and manufacture of the constituent elements of the system are located in Ukraine, and the rest in Russia.

The Zenit launch vehicle is intended for the placement of automatic spacecraft with a mass of up to 13.7 tonnes into a circular orbit 200 km high and with an inclination of 51°. Engineering ideas were also developed whose realization would make it possible to support the launch of manned spacecraft in the future.

The rocket is executed in a tandem two-stage configuration with the use of relatively clean fuel components—liquid oxygen and kerosene—in an ecological regard. The power plant of the first stage is a four-chamber engine with a thrust at ground level of 740 tonnes, or 806 tonnes in a vacuum. It is executed with rocking combustion chambers and the secondary combustion of generator gas. This is currently one of the best domestic or foreign models in its absolute and relative parameters, as well as its technical level. The second stage has a single-chamber sustaining engine and a four-chamber steering engine. The control system for the launch vehicle utilizes terminal-control algorithms, and provides for high precision in orbital insertion and an opportunity to perform deep lateral maneuvers during the second-stage leg of the flight for the purpose of reducing the number of places where the separated stages of the RN fall.

The launch of the Zenit RN is monitored by a safety system. It is structured on the basis of the on-board digital computer complex (BTsVK) of the launch vehicle control system, which supports the processing of information received from sensors tracking the operability of systems, units and assemblies of the vehicle, and issues commands to localize an emergency situation.

The launch complex (SK) has two launch installations, a cryogenic center and more than 50 technological systems. Service towers are also used, through which cosmonauts may enter the craft if the Zenit becomes the principal carrier for manned spacecraft and replaces the "seven." All operations for the transport, placement of rockets on the launch pad, and hook-up of the fueling, air and electrical service lines are performed automatically, and the rocket can be launched in virtually an hour and

a half after it is positioned. One can see curious crew members with nothing to do at the fully automated launch complex who have come to ground "zero" again and again to enjoy a spectacle that can be seen nowhere else.

It must be noted that the safety of the operations to prepare the Zenit RN on the SK is assured through the remote control of the processes of placing it on the launch pad, hooking up fuel and other service lines, fueling and getting the vehicle ready and launching it. Even the work to bring the RN back to its initial state in the event a launch is canceled is performed in an operation-by-operation mode, with remote control of the operations from the SK command post.

There is an engineering complex apart from the launch complex, which includes an installation and test wing, storage areas for the launch vehicles and spacecraft, engineering buildings and other structures. This area is very well appointed and landscaped.

The flight testing of the Zenit RN began at the beginning of the 1980s. It did not go smoothly. When the question arose of accepting it into service, the leaders of the cosmodrome, headed by Lieutenant-General Yu. Zhukov, were categorically against it, since some of the characteristics of the rocket had not been confirmed. The scientific and technical council of the cosmodrome almost unanimously adopted a negative finding based on the results of testing the vehicle. It was sent to all concerned organizations. In reply came the demand to accept the Zenit for service. The leaders of the cosmodrome signed the report of the State Commission with a minority opinion as a result. But obviously no one took account of the test personnel, and the launch vehicle was accepted into service.

There were no launches from that time for about a year, and then came October of 1990. The fourteenth launch. Two of the preceding thirteen had ended in accidents. This was the first series-produced rocket. The launch vehicle was prepared for launch by the highly experienced specialists, and today colonels, Yu. Zorin, Ye. Aleksandrov, A. Melik-Guseynov and D. Chistyakov, among others. It was clearly visible from the observation post as the rocket rose to an altitude of about 70 meters, hung for an instant over the launch pad and slowly started to descend. A trail of fire tore out the side of the tail section. A column of flame then flew up over the launch installation. A roar sounded—the sound from the combustion chambers that had been operating for a few seconds, and then a powerful blast wave. The explosion turned out to be directional, since the launch vehicle crashed, as it were, into the excavation of the gas chute. The launch system of about 1,000 tonnes was lifted about twenty meters by the blast wave, turned 45° and fell back onto the launch structure in that position. The elements of the rocket engine, weighing more than 2—3 tonnes, were thrown in the direction of the longitudinal axis of the gas chute for 2—3 km. The spacecraft fell three hundred meters from the pad.

A number of organizational measures were carried out immediately following the accident: the documentation, magnetic tape recordings of the preparation process and telemetric information were "arrested" for study, an assessment of the material damages was performed—they totaled 40—45 million rubles—and the remnants of the launch vehicle and spacecraft were gathered up and organized for inspection.

The first night at the pad after the accident... Illumination from the neighboring launch installation and the moon create a picture of the space catastrophe. Something squeaks and hisses below. Noises pop and crack. Some fires can be seen in the area of the crash. Fragments of the rocket and heaps of wildly scattered metal are all around.

The cause of the explosion, as established by the commission, was the failure of the engine installation, which occurred due to one of its elements—the sylphon of the main oxidizer line—catching fire. There were two attempts to launch the Zenit after the accident, both unsuccessful. Such outcomes are usually not uncommon in flight design testing, and the efforts of specialists from the design bureau and the test personnel of the cosmodrome made the planned launches for 1992 successful ones. The hope arose of continuing joint space programs among Ukraine, manufacturing the launch vehicle, Kazakhstan, on whose territory the cosmodrome is located, and Russia, supporting the testing and operation of the rocket.

I would like to add a few words regarding the dramatic fate of this launch vehicle, today the best in the world. It has very modern engineering performance characteristics and a fully automated start. The Zenit outwardly also arouses a feeling of delight in experts. But... A launch was planned for 17 November 1992, after which the Zenit could be given up for lost. The Zenit, in my opinion, is one of the last slender threads that links Kazakhstan, Ukraine and Russia. The joint space programs of the three countries will be called into question if that thread is broken, since the launch vehicle itself is manufactured in Dnepropetrovsk at Yuzhmash, which has now begun to specialize in the output of trolleybuses, the launch pad is in Kazakhstan, and we—Russian servicemen—are engaged in the operation and testing. Our separation will become greater and greater if that thread is broken.

Why cannot Ukraine, at the same time, assign its soldiers and officers (within the framework of the strategic forces) to serve at Baykonur? The departure of the Ukrainian servicemen from the cosmodrome, after all, was a "blow" to this unique complex that we will barely be able to recover from over the next ten years. And they are leaving not because they do not like the work at the cosmodrome, but rather because they are afraid of being left without a motherland. I met a former subordinate of mine—the Ukrainian Lieutenant-Colonel (Reserves) Vasiliy Opanasovich Murmylo—before the last launch

of the Zenit; he had been discharged more than three years ago, and was still waiting for the apartment promised to him in the Poltava area. He told me with tears in his eyes that his homeland had rejected him, they were not giving him an apartment in Ukraine and that he had to go either to Kaluga or to the Moscow area, but that he had to wait another two years, since his turn had already passed in Ukraine but he was only just starting in Russia. How many such people are there? The Zenit could thus become at least a straw for these officers, who gave their whole lives to space science.

I was on my regular leave during the preparations for the November launch, but I decided to travel to Baykonur, since my family was still there. The "flower of technical thought," people whose meaning in life is to work for the assimilation of space, came to the launch. They were of course not able to manage the launch preparations without problems, since the process of the universal decline in the quality of production has also affected the space sectors. But the day of the launch did come. As a visitor I did not go to the "bunker" where the launch of the Zenit was being performed, but rather to the observation point. The technical leaders who were not taking part in the launch but had a vital vested interest in its results were already there. They included Deputy General Director of the Russian Space Agency Boris Dmitriyevich Ostroumov, Energiya RN Deputy Chief Designer Vyacheslav Mikhaylovich Filin, Deputy General Designer and Energiya NPO [Scientific Production Association] General Director Yuriy Mikhaylovich Danilov, and many others.

The conversation was awkward; everyone was in agonizing suspense. They glanced at the outlines of the launch vehicle on the pad. Information on the principal stages of the preparations for launch came over the loudspeaker. Suddenly it could be felt that something was wrong. A run to the observation post. I found out that a five-minute delay had occurred owing to the impossibility of closing a fuel valve—the combat crew of Lieutenant-Colonel D. Chistyakov closed it again manually. And finally 12:47 came. Launch! Everyone listened intently to the report on the fulfillment of the commands of the flight cyclogram. Everything was fine. The separation of stages took place... ignition of the steering and sustainer engines of the second stage... jettisoning of the cowling... shutdown of the sustainer engine of the second stage. Now only the steering engines were going, bringing the launch vehicle to the nominal insertion point. Shutdown of the steering engines... separation of the craft.

All were engulfed in a feeling of joy, greater than at the launch of the first Zenits. This was, after all, one more argument against the critics of our space program, and it meant that one of the last threads was not broken, that a chance still remains for us to work together.

Articles Not Translated

00000000 Moscow AVIATSIYA I KOSMONAVTIKA in Russian Nos 11-12, 1993 (signed to press 10 Sep 93)

[Text]

Fifty Years of TsVNIAG ... C2

Threat—On Course (Major Ye. Polyakov, N. Rosanov) ... 6-8

A Tailored Approach to Training (Colonel Yu. Samolayev) ... 9

'AL'—the Engines of Arkhip Lyulka (Lieutenant-Colonel V. Kudryavtsev) ... 16-17

What We Have We Do Not Keep? (S. Vakhrushev) ... 18-19, 35

Le Bourget 93—Parade of Technologies and Collaboration (A. Andryushkov) ... 20-27

Military Transport Aircraft (Major A. Gavrilov) . 28-29

A Trend Toward Decline in the Accident Rate (Colonel-General of Aviation (Retired) V. Filippov) ... 30

The 'Farman-IV' (Colonel V. Zaretskiy) ... 30-31

How the MiGs Went Into Spins (A. Belosvet) ... 32-35

The Wings of Russia (V. Tkachev) ... 36-38

Foreign Manned Space Flight. Results for 1992 (K. Lantratov) ... 44-47

Black Sea Eagle (Colonel A. Kanevskiy) ... 48

"...And a Flaming Motor in its Breast" (Leonid Yakutin) ... C3

Publication Data

94UM0394G Moscow AVIATSIYA I KOSMONAVTIKA in Russian Nos 11-12, 1993 (signed to press 10 Sep 93)

[Text]

English title: AVIATION AND COSMONAUTICS

Russian title: AVIATSIYA I KOSMONAVTIKA

Editor: V.V. Anuchin

Publishing house: Voyenizdat

Date of publication: November-December 1993

Signed to press: 10 September 93

BULK RATE
U.S. POSTAGE
PAID
PERMIT NO. 352
MERRIFIELD, VA.

Foreign Broadcast Information Service (FBIS) and Joint Publications Research Service (JPRS) publications contain political, military, economic, environmental, and sociological news, commentary, and other information, as well as scientific and technical data and reports. All information has been obtained from foreign radio and television broadcasts, news agency transmissions, newspapers, books, and periodicals. Items generally are processed from the first or best available sources. It should not be inferred that they have been disseminated only in the medium, in the language, or to the area indicated. Items from foreign language sources are translated; those from English-language sources are transcribed. Except for excluding certain diacritics, FBIS renders personal names and place-names in accordance with the romanization systems approved for U.S. Government publications by the U.S. Board of Geographic Names.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by FBIS/JPRS. Processing indicators such as [Text] or [Excerpts] in the first line of each item indicate how the information was processed from the original. Unfamiliar names rendered phonetically are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear from the original source but have been supplied as appropriate to the context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by the source. Passages in boldface or italics are as published.

SUBSCRIPTION/PROCUREMENT INFORMATION

The FBIS DAILY REPORT contains current news and information and is published Monday through Friday in eight volumes: China, East Europe, Central Eurasia, East Asia, Near East & South Asia, Sub-Saharan Africa, Latin America, and West Europe. Supplements to the DAILY REPORTs may also be available periodically and will be distributed to regular DAILY REPORT subscribers. JPRS publications, which include approximately 50 regional, worldwide, and topical reports, generally contain less time-sensitive information and are published periodically.

Current DAILY REPORTs and JPRS publications are listed in *Government Reports Announcements* issued semimonthly by the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161 and the *Monthly Catalog of U.S. Government Publications* issued by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

The public may subscribe to either hardcover or microfiche versions of the DAILY REPORTs and JPRS publications through NTIS at the above address or by calling (703) 487-4630. Subscription rates will be provided by NTIS upon request. Subscriptions are available outside the United States from NTIS or appointed foreign dealers. New subscribers should expect a 30-day delay in receipt of the first issue.

U.S. Government offices may obtain subscriptions to the DAILY REPORTs or JPRS publications (hardcover or microfiche) at no charge through their sponsoring organizations. For additional information or assistance, call FBIS, (202) 338-6735, or write to P.O. Box 2604, Washington, D.C. 20013. Department of Defense consumers are required to submit requests through appropriate command validation channels to DIA, RTS-2C, Washington, D.C. 20301. (Telephone: (202) 373-3771, Autovon: 243-3771.)

Back issues or single copies of the DAILY REPORTs and JPRS publications are not available. Both the DAILY REPORTs and the JPRS publications are on file for public reference at the Library of Congress and at many Federal Depository Libraries. Reference copies may also be seen at many public and university libraries throughout the United States.

END OF
FICHE
DATE FILMED
20 Oct 94